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ENGINEERING AND PHYSICAL PROBLEMS.

On two occasions at the recent Institute convention, President C. F. Scott emphasized the difference between what he called "engineering" and "commercial" problems. His views in this matter drew protests from several members present, but it seems to us that he is entirely right.

The Two Questions.

We should, however, term the two sides of the whole problem somewhat differently. There is a commercial problem which has to do with the greatest return on capital invested or the expenditure of the least amount of money to accomplish the work in hand. There is, on the other hand, a purely physical question, which is concerned only with the possibilities of the apparatus or installation under consideration. Before one can say how much money should be expended for a certain piece of apparatus, one must know what that apparatus will do, and in answering the latter question, the element of cost does not enter. After the possibilities of the apparatus or installation are known, the commercial problem can be solved and not before.

THE PACIFIC CABLE.

Ever since the first cable was successfully operated under the Atlantic, it has been a pet theme for Presidents, in their messages to Congress from time to time, to emphasize the advantages which would accrue to the United States if a similar cable were stretched under the Pacific Ocean connecting San Francisco or some other point on the western coast of the United States with the Orient. Long before possessions of any magnitude in the far East country were dreamed of, the subject of an American-owned Trans-Pacific cable was talked about, and if the plans laid down by legislators and fostered by executives had been followed, much good would have been accomplished. But like many another good institution, the matter of a government-owned Trans-Pacific cable was thrashed in and out of many sessions before the late John W. Mackay made his offer to the United States Government to construct and maintain a cable as a private business enterprise.

Outside of Political Influence.

This businesslike statement from a man who had become world-renowned and famous through his connection with trans-oceanic cable enterprises, was the beginning of the end of the separateness of the United States and the far East. The lifting of this subject out of the realms of political interference, made way for the speedy consummation of the project.

An All-American Route.

The condition under which the charter was awarded to the Pacific Commercial Cable Company is a matter of history, and needs to be touched upon but briefly here. The Pacific Commercial Cable Company was incorporated under the laws of New York on September 23, 1901. Its charter called for a route, such that it would have a station on no other but American soil. This necessitated the equipping of a colony on Midway Island, a place hitherto uninhabited except on occasions of infrequent visits by the savage races of that locality.

The Commercial Value.

From a commercial point of view, one of the immediate effects of the determination to lay this cable was a reduction in the rates imposed by European companies, the cost for a word from San Francisco to the Philippines being reduced from $2.35 to $1.60. Before entering into this contract, the new company bound itself to charge only $1.00 a word from San Francisco to Manila and China, and fifty cents a word to Honolulu, and within two years further to reduce the charge to the latter point to thirty-five cents.

The Strategic Importance.

The war with Spain and the acquirement of the Philippine Islands made the cable a necessity from a strategical point of view. The late President McKinley was enthusiastic over the possibilities of this cable, and his advocacy has been heartily seconded by the present chief executive, Theodore Roosevelt.

The Cable Opened on Time.

The great experience which the cable laying companies have had, and the propositions which have been overcome since the original trans-oceanic cable was laid, have made the physical effort of cable laying easier than the ordinary citizen imagines. There was a great deal of doubt as to the possibility of the cable being in such a state of completion as to make it possible to transmit a message on Independence Day, 1903. By those well informed, however, and acquainted with the wonderful foresight of which the late John W. Mackay was possessed, and of the enterprise and perseverance of his son, Mr. Clarence H. Mackay, who has taken the reins of control into his hands, and of the expertness of his associates, the claims of the company were never for a moment doubted. The first message was transmitted by means of this cable on July 4, 1903.

THE TWENTIETH ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The twentieth annual convention of the American Institute of Electrical Engineers, which was held at Niagara Falls the week beginning June 29, was in point of interest and attendance of members, one of the most successful that has been held. The register of members and guests reached nearly the 500 mark, though not an inconsiderable number of these should be credited to the Society for the Promotion of Engineering Education, which convened at the same place on July 1.

The First and Second Days.

The interest of the first day centered in President Scott's address, which gave a review of the work of the past year and called attention to the noteworthy happenings and the substantial growth of the Institute. The second session was devoted to the consideration of railroad papers, and here some valuable contributions to the railway problem were made. In some quarters the value of so-called theoretical discussion is questioned, but when theoretical deductions are based upon sound experimental results, the value of such discussions should be apparent. The Institute paper by Mr. Frank L. Sessions drew attention to a successful application of storage battery locomotives. The statement made by Mr. E. A. Sperry that storage battery locomotives are not only more efficient but have a greater capacity per pound than compressed air locomotives will, undoubtedly, draw vigorous protest from our compressed air friends.

Transmission Papers.

The discussion on the introductions presented by the Committee on High-Tension Transmission was satisfactory, and drew statements from a number of engineers who have been working in this particular field. One drawback to these discussions was the number of subjects to be considered. It was found necessary to hold two sessions on a warm day, yet the interest was sufficient to hold a goodly number of members until nearly six o'clock.

Thursday's Session.

At Thursday's session a number of papers of miscellaneous character were read. The chief points of interest of this day's work were the steps taken toward the adoption of the cadmium cell as the standard of electromotive force, and the description by Professor H. J. Ryan of his cathode ray alternating-current wave indicator.

Engineering Education.

On Friday, the joint session held with the Society for the Promotion of Engineering Education brought out a number of valuable papers on the education of the engineer. These were nearly all from practising engineers, this fact giving them particular interest. Throughout all there was a plea for a broader education. It is not only natural but right that those men who have had experience should state what seems to them to be lacking in the training of the engineering student, though it is possible that some of the authors do not realize how crowded the courses offered at our technical colleges are, and to what extent the addition of these broadening studies will cut down instruction in specialized work.

Social Side.

The social side of the convention was most enjoyable, as the Local Committee spared no pains to provide for the comfort and pleasure of the visiting members. Niagara Falls has many advantages as a place of meeting, and there is no doubt that the twentieth convention of the Institute will long be remembered with much pleasure by those members who were able to attend.

THE NATIONAL ASSOCIATION OF ELECTRICAL CONTRACTORS.

The third annual convention of the National Association of Electrical Contractors will be held at Detroit, Mich., July 15, 16 and 17. An exhibit will also be made in conjunction with the convention by the manufacturers of electrical supplies.

The Representative Electrical Contractors.

This association is made up of the representative electrical contractors of the United States. The national body had its origin in a state association, which under organization was so much benefited that it at once realized the value of an inclusive and broad affiliation.

The Growth of the Organization.

Under the leadership of its charter members the national body then assumed influential proportions. Its governing body includes representatives from a number of states as directors, many of whom are executive officers in similar local orders. During the past year there has been a large increase in membership, and the continued success and growth of the association are evidently assured.

VELOCITY OF OBJECTS FLOATING IN WATER.

On another page of this issue will be found a communication from Mr. George H. Gibson, of Boston, Mass., commenting upon a recent criticism of a statement appearing in a technical paper, that objects floating in running water move more swiftly than the water.

Mr. Gibson, while not agreeing either with General Bentham or the editor of the paper in which the communication first appeared, does not fully agree with our comment, although the conclusions reached do not differ from ours. He discusses the problem clearly and logically, and his objection to our method seems to be that we do not show that the object would float more slowly than the surrounding water.

In our comment, we purposely attack the problem in a different way. The original letter of General Bentham conveys to the general reader the impression that objects floating on running water are acted upon by a greater force than the water, and must, therefore, float faster than the surrounding water. It was this particular idea that we wished to dispel.

Twentieth Annual Convention of the American Institute of Electrical Engineers, Held at Niagara Falls, June 29 to July 3, 1903.

Proceedings of the Last Three Days.

TUESDAY evening, June 30, Mr. Leonard Wilson delivered an interesting lecture on "Reverse-Current Circuit-Breakers and the Protection of Transmission Lines." Mr. Wilson described a recent type of apparatus which has been developed, and which consists of a three-legged transformer wound so that a fault on one line would be indicated at the station, so that the line could be cut out. A further development had produced an apparatus which does this automatically. The apparatus was shown in operation, and was examined with considerable interest.

NIAGARA DAY, WEDNESDAY, JULY 1.

The sessions held on Wednesday were given up to the consideration of introductions to discussion submitted by the members of the Committee on High-Tension Transmission. These introductions were printed in the issues of the ELECTRICAL REVIEW of May 30 and June 27.

The morning session was called to order at 9.30, President Scott occupying the chair. The first introduction taken up was that by Mr. C. E. Skinner, of Pittsburg, Pa., entitled "Methods of Bringing High-Tension Conductors Into Buildings." This paper provoked a lively discussion, during which a number of engineers connected with high-tension transmission systems pointed out the advantages and disadvantages of the methods suggested by Mr. Skinner, and described the methods in use in their respective installations.

Communications were read from Messrs. Henry Floy, of New York; M. H. Gerry, Jr., of Helena, Mont.; O. H. Ensign, of Los Angeles, Cal.; A. L. Mudge, of Pittsfield, Mass., and others. These communications pointed out an objection to the use of tile, as suggested by Mr. Skinner, since the arrangement shown in the paper would not prevent birds and insects from finding their way into the tile and causing trouble. The arrangement for preventing snow and ice from falling upon the wire was criticised, and it was suggested by several that the wire should either enter the building at the gable end, or a gable should be built in the roof over the point where the wires enter.

Mr. Floy said that a simple hole in the wall was the best thing. When a traveling crane is used the wire may enter the building at the side, but an extension should be provided, allowing the wires to drop down below the crane and come up inside. This arrangement would also keep out the cold.

Mr. Ensign stated that his company was using a twelve-inch sewer pipe for entering the buildings. The wires are not over No. 1 B. & S. gauge, and are carrying 30,000 volts. The tile is set in the building at an angle of thirty degrees. There was no need to close the opening, although the temperature outside at times falls nearly to zero.

Mr. F. C. Pierce did not think that the walls should bear the strain of the line, as it was sure to cause bulging eventually.

The discussion was then taken up by the members present. Mr. R. D. Mershon, of New York, had used various methods, and thought that both the tile and the glass tubing were good. He had, however, found some difficulty in getting glass which would stand the excessive change in temperature. When frost collects in the tube there is a discharge in the line, which continues until the frost is dissipated.

Mr. R. F. Hayward, of Salt Lake City, said that the climatic conditions were very important in considering the method of entering a building. He was surprised at the closeness with which wires were strung in the East. On his system, operating at 40,000 volts, the line wires are kept six feet apart. They entered the building through an opening two feet square, and more than once he had seen arcs jump twelve inches to the iron casing of the opening. He did not think that eighteen inches or two feet is enough spacing between wires. At the Mercur Mills the 20,000-volt lines entered the gable end of the brick wall, the outlets being placed four feet apart. The holes are eighteen inches square, and are closed by two plates of glass, one flush with the inside and the other with the outside surface of the wall. These glass plates are pierced by a two-inch hole, through which a tube is carried, covering the wire. There was some trouble at first in obtaining satisfactory glass. Porcelain was much stronger, and will probably be used in the future.

Mr. V. G. Converse, of Pittsburg, held that the insulation should be protected from the weather—that a drain shed should be built out over the entrance, or a gable run down. The wire should be dropped down from the last pole, and come up to a bracket in the drain shed.

Mr. Percy H. Thomas, of Pittsburg, said that the rain shed is good, as it makes indoor construction possible. This shed may be constructed within the building. Much would be gained by mounting the insulators on an insulating panel.

Mr. P. M. Lincoln, of Pittsburg, said that trouble would be caused by taking up the end strain of the line outside, as Mr. Converse had suggested. The strain should be taken up within the building, as proposed by Mr. Skinner, allowing indoor construction to be used.

The second introduction to be taken up was that of Mr. R. D. Mershon, of New York, entitled "The Grounded Wire as a Protection Against Lightning." A communication was read from Mr. R. S. Kelsch, of Montreal, giving some experiences with the Lachine Rapids Hydraulic and Land Company's system. In this system one carbon lightning arrester is installed at each end of each line. No choke coil is used. This was all right for 500-volt lines, but for 2,200-volt lines it gave trouble. They also had experienced some trouble where their lines passed under the lines of other companies.

Dr. F. A. C. Perrine, of Pittsfield, Mass., thought that the grounded line was some protection if it was properly grounded. He did not approve of the use of barbed wire, because, due to the method of manufacturing, this wire can not be relied upon. If a barbed conductor were manufactured in the same way as cables are made, and flat points were used, there might be some advantage in using this. The barbs would assist in discharging the atmosphere if it were still, but would not aid when the atmosphere is in motion. He had conducted some tests to determine the amount of energy lost, due to induction, with a grounded wire, but had not been able to detect any. He thought that the immunity of power lines from atmospheric disturbances might be due to the use of iron poles, which bring the earth potential nearer to the wire.

Mr. C. J. Wurts, of Pittsburg, Pa., noticed that Mr. Mershon had not

abandoned the spark-gap lightning arrester. He further disagreed with Mr. Mershon as to the effect of the motion of the cloud. The earth and the cloud formed a huge static machine, and when a discharge took place did not start from one point of the cloud, but from many points in converging streams. He thought Mr. Mershon was bold to give figures of the value of the grounded wire.

Mr. Percy H. Thomas spoke of the complexity of the problem of protecting against lightning in commercial service. He called attention to the experiments made by Sir Oliver Lodge some years ago, which had shown that cages surrounding the wire did not offer perfect protection. He thought it would be well to go slowly in putting dependence on the grounded wire.

Dr. A. E. Kennelly, of Cambridge, Mass., said that nothing would protect against a discharge of lightning to the line, but that a neighboring wire should afford some protection against atmospheric surges if the line wire were surrounded. The change in electrostatic capacity, due to the grounded wire, is trivial. Electromagnetic effects would be more serious.

Mr. Lincoln thought there would be some protection to the line, as the grounded wire would act as a short-circuited secondary, and protect the line against electromagnetic effects. In the West the transmission lines become charged due to the wind, an effect which was not apparent in the East.

Mr. D. B. Rushmore, of Pittsfield, Mass., called attention to the effect of altitude in mountainous countries, where the grounded wire should afford some protection against the change of potential.

Mr. J. F. Kelly, of Pittsfield, Mass., spoke of some of the early troubles on telegraph lines, due to atmospheric discharges. While the grounded wire should afford some protection, he did not think it would pay for the increased complication.

Mr. R. F. Hayward thought that engineers were working somewhat in the dark, as there are but little reliable data on the effects of atmospheric discharges. He suggested that all central stations and transmission plants should cooperate to collect systematically all information obtainable during electrical storms. He thought that if the engineer in charge would hasten to the point where trouble occurred as soon as possible, and make a careful record of what had happened, within a year we would be in a far better position to discuss the matter than at present. He spoke of the experience of the Telluride system in Utah, where transmission was first begun at 2,000 volts, where no great precaution was taken to guard against atmospheric disturbances. They had had no trouble on this system until the increase in voltage had called for an increase in insulation. Now, every storm finds a weak point in the system. All dry transformers have been sifted out in this way. They had no trouble where their lines passed under other wires, nor from atmospheric discharges. All protective devices should be carefully insulated.

Mr. W. L. Waters, of Milwaukee, Wis., explained his method of calculating the shielding effect of grounded wires. His figures give results differing somewhat from Mr. Mershon's. He stated that European engineers believe the grounded wire is more trouble than it is worth.

Mr. J. P. Jackson, of State College, Pennsylvania, said that the problem was to keep the ground potential near the line, which was accomplished by the grounded wire. He thought that Mr. Mershon should have included the constants of the grounded wire in his calculation, and that the effects of the wire had been somewhat exaggerated.

Mr. Mershon stated that his figures were based upon an actual case—that the atmospheric effects were not due so much to the charged particles which come into contact with the wire as to the effects induced by charged particles near the wire. In his discussion he had used the term "cloud" to designate any mass of air in motion, but not necessarily visible.

Mr. W. J. Hammer described the system used in certain Italian transmission plants. The arresters are placed in the building and jets of water are sprayed upon the wire without the building. They had no trouble whatever from lightning or atmospheric discharges.

Mr. Percy H. Thomas read his paper entitled "The Testing of Electrical Apparatus for Dielectric Strength." A communication from Mr L. A. Hawkins, of Pittsfield, Mass., called attention to the danger of using the spark-gap when testing apparatus insulated by oil, as the insulation will be punctured; but, due to the presence of the oil, the breakdown may not be perceived at the spark. He further called attention to the danger caused by the change of wave-form when a regulating resistance is used in the transformer circuit.

Mr. Gerry thought that the apparatus should be tested under actual conditions, but there is a temperature lag which may cause a condensation of moisture on the apparatus. The same view was taken by Mr. J. S. Peck, who stated that apparatus just installed was under the worst condition to be tested.

Mr. H. G. Stott, of New York, thought that the paper discouraged insulation tests, but unless these were made the purchaser had no way of knowing what factor of safety his apparatus possessed.

The discussion by Messrs. Lincoln, Waters, Skinner and Mershon brought out the difference between insulation tests and testing other materials. Insulation tests have two purposes—to show that sufficient insulating material has been used, and that the work has been carried out without injury to this. For this reason the test must be made on the completed apparatus.

The effect of regulating resistance in altering wave-form was emphasized by President Scott and others. Where the resistance is large it becomes the controlling factor, and causes a peaked electromotive-force wave.

In reply, Mr. Thomas spoke of the troubles of testing insulation. When making extremely high disruptive tests apparatus may be ruined which would otherwise have been entirely satisfactory in service. Every precaution must be taken to carry out the work. When static voltmeters are used in place of the spark-gap for determining the potential, great care must be taken. Fatigue tests are of little value, as the material weakens, due to continued strain. The distortion of the electromotive-force wave, due to the regulating resistance, is not great if the transformer is loaded. He did not think a relative study of dielectric strength and elastic limits of insulating materials would be of value.

At the conclusion of these remarks Dr. F. A. C. Perrine described briefly some recent work of his own in calculating a 350-mile transmission system. Such systems are usually laid out with duplicate or triplicate lines. If each line is continuous and a breakdown occurs, it will throw out the entire line, with disastrous effects upon the regulation, unless large amounts of copper are used. To avoid this contingency he had adopted the plan of cutting the lines up into sections. These sections might be ten or fifty miles in length, and were run between suitable switching substations. A breakdown at any point, then, threw out only that one section, leaving all the other sections of that line in operation. The switching could be done either by an attendant or automatically.

The full discussion brought out by these papers made it necessary to call an afternoon session in order to complete the consideration of the reports made by the Transmission Committee. This was called to order at 2.30 P. M. by President Scott, and a paper by Mr. P. M. Lincoln, entitled "The Choice of Frequency for Very Long Lines," was taken up.

A communication from Mr. F. G. Baum, of Palo Alto, Cal., stated that so far as the line is concerned, a low frequency is better. Other considerations often make a higher frequency desirable. This is the case with the California transmission systems, where a large part of the energy is distributed for lighting systems in small towns.

In a letter from Mr. B. A. Behrend, of Cincinnati, the author stated that he did not think resonance effects need be anticipated, and in designing a line all the apparatus should be considered, not merely the line alone.

Mr. C. O. Mailloux, of New York, thought that it would be well to determine the lowest frequency which could be used satisfactorily in lighting and adopt that.

Mr. Stott stated that his company had carried out some tests at twenty-five cycles, with four-watt incandescent lamps. These were thrown on alternately on 110-volt direct-current and alternating-current circuits. and they had had no complaints whatever, and are now operating 30,000 incandescent lights at twenty-five cycles.

Mr. Mershon said that in many cases the installing engineer was forced to use that frequency for which apparatus was obtainable. He suggested the use of synchronous apparatus for improving the regulation of the line, a suggestion with which Mr. Lincoln did not agree.

Dr. Perrine called attention to the Bay Counties' Oakland transmission system, described recently by Mr. Baum, in which regulation was effected automatically.

Mr. Blackwell's paper, entitled "Star and Delta-Connection of Transformers," in the absence of the author, was read by Mr. Mershon.

Mr. J. S. Peck read a contribution to the discussion, entitled "Grounded and Ungrounded Transmission Circuits." In this the effects of grounding one or more legs of a transformer were considered, and it was shown that under certain conditions an excessive voltage could exist between the secondaries or the secondary and the ground. An abstract of this contribution will be printed in an early issue of the ELECTRICAL REVIEW.

Mr. Hayward called attention to the advantage of using the delta-connection, which enables the system to operate under a short-circuit. When high voltages are reached it is well to ground the neutral.

Mr. Gerry has obtained equal results with either delta or star-connection. The conditions indicated by Mr. Peck are not merely theoretical, but are very real. The advantage of the delta arrangement is that transformers can be cut in and cut out without interfering with the operation of the system.

Mr. P. N. Nunn, of Telluride, Col., also spoke of the real dangers pointed out by Mr. Peck, and stated that in one case he had seen an arc jump eight feet. There is less trouble if all the lines break at once. He is using the star-connection with a grounded neutral.

Mr. Thomas thought that the theoretical rise in voltage pointed out by Mr. Peck would not be reached, due to the change of inductance of the transformer.

Mr. Peter Junkersfeld, of Chicago, spoke of the Edison system in that city, and suggested that much trouble might be avoided if the single-pole switch were abandoned for a three-pole switch. The advantages of being able to cut out one transformer from a line were not great when there were many transformers in service. For this reason his company had recently installed three-phase transformers.

Mr. Henry W. Fisher read his paper, entitled "Electric Cables for High-Voltage Service." Mr. Philip Torchio, of New York, contributed a paper, entitled "The Operation and Maintenance of High-Tension Underground Systems," which was read by Mr. W. F. Wells. Mr. H. G. Stott read his paper, entitled "The Use of Automatic Means for Disconnecting Disabled Apparatus." These papers have all been published in the ELECTRICAL REVIEW.

A communication from Mr. W. G. Carlton, of Chicago, was read by Mr. Wells. Mr. Carlton described the Chicago system and called attention to the small damage done to high-tension cables when short-circuited. Mr. Wells himself did not think that automatic devices were necessary, as the use of a sufficient number of instruments at the generating station would enable the operator to cut out a disabled line before serious trouble was caused at the station.

Mr. W. C. H. Eglin, of Philadelphia, said that his system was using a high frequency, and that the company found a reverse-current circuit-breaker necessary to prevent flashing over of the direct-current side of the rotaries. They were also using a speed-limit device, and found it necessary to limit the energy put into a short-circuit. The cables were kept separate at the receiving end, and they had no trouble in operation.

Mr. Stott stated that his company was operating 120 miles of underground paper cable at 11,000 volts, and had found in all only one weak cable. Certain of the cables which became hot were found to be carrying heavy currents in the lead sheathing. This trouble had been overcome by sectioning the lead in the sheathing. He did not think that a reverse-current circuit-breaker was of any value, and had found that in case of accident all the alternating-current breakers went out simultaneously. He then described a device used abroad which prevents this.

Replying to questions, Mr. Fisher stated that his company was conducting tests on the temperature rise of underground cables, but that data was not yet in shape for publication. If paper cables are maintained at 100 degrees centigrade, the paper becomes brittle. They have cables now operating and guaranteed for 22,000 volts commercial service.

Wednesday afternoon special trolley cars were provided for those members who did not attend the afternoon session, which carried them on a visit of inspection to the Canadian power developments. A trip was then made down the Niagara River on the Canadian side, returning by the Great Gorge route. In the evening an enjoyable musical entertainment was given at the International Hotel. The ground was lighted with Cooper Hewitt lamps.

EXCURSION DAY, THURSDAY, JULY 2.

The morning session was called to order at 9.30 by President Scott. Professor J. W. Esterline read a paper prepared by himself and Mr. C. E. Reid, entitled "The Factors Which Affect the Energy Losses in Armature Cores." This paper is a study of the effect of the core losses in armatures, as affected by the shape of the armature stamping and the number of field-poles. The results of these tests are shown graphically. An abstract of this paper will be published in a later issue of the ELECTRICAL REVIEW.

This paper was discussed by Dr. W. E. Goldsborough, Professors S. F. Franklin and A. E. Kennelly and Mr. Leonard Wilson.

Dr. Goldsborough read a paper, prepared by himself and Mr. P. E. Fansler, on "Central Station Economies," which describes a test made of the generating station of the Union Traction Company of Indiana in the spring of 1902. The

boiler room contains Babcock & Wilcox boilers, chain grate stokers, and the engine room, three cross-compound condensing Corliss engines, each rated at 2,000 horse-power, and each driving a 1,000-kilowatt three-phase generator with rotating fields. Tests show that the efficiency of the boilers, expressed in terms of the total calorific power of the whole, is 79.6 per cent. Some interesting curves were given, showing the distribution of load between two pairs of engines when operating in parallel. The average efficiency of the generating units—that is, the ratio of the generator output and indicated horse-power—is nearly ninety per cent. The average coal consumption per cent indicated horse-power was 2.85 pounds. The weight of water required to develop an indicated horse-power varied from 2.26 to 2.29 pounds. In approximating the actual and water consumption of engine and generators, the assumption was made that the auxiliaries required fifteen per cent of the steam generated. Replying to a question, Dr. Goldsborough stated that the efficiency of the high-tension transmission line was about seventy-four per cent, and that of the distributing line about seventy-five per cent. This provoked a good deal of discussion, as many present could not understand why such refinements in station design had been adopted, while a line having such poor efficiency was installed. Dr. Goldsborough stated in reply that the plans of the station contemplated an extension, and, when desirable, more copper could be added to the line. It was suggested that Kelvin's law might be applied to this line, but Mr. J. F. Kelly said that Kelvin's law was only applicable when other things were equal—that in many cases other considerations determined the amount of copper to be used.

A paper by Mr. Ralph L. Montague, entitled "The Electrical Equipment of a Gold Dredge," was read by Mr. M. H. Gerry, Jr. This described the types of installation which had been found satisfactory for the work of dredging, and the author stated that he did not suppose that even one per cent of the dredging ground in existence is at present being mined. The apparatus and process are both in an experimental stage, and there is much chance for improvement, both electrically and mechanically.

Mr. Skinner commented on this use of motors, stating that the service was very severe, as frequently the motors are stalled.

President Scott stated that it had been intended to have Professor Elihu Thomson outline a proposed electrical conference in 1904. As Professor Thomson was absent, due to sickness in his family, he called upon Professor Kennelly, who explained that a preliminary meeting of the Committee on Organization had been held, at which it was decided to hold a congress next year at the Louisiana Purchase Exposition, and that the government will be requested to extend invitations to other governments to send delegates. The scope and purpose of this congress had not been entered upon.

Professor Henry S. Carhart, of Ann Arbor, Mich., read a paper entitled "The Legalized Standard of Electromotive Force." In this he called attention to the doubt which exists concerning the correct value of the electromotive force of the Clark cell. The legal value in this country is 1.434 volts at fifteen degrees centigrade. A number of observers since this time have obtained values which point toward 1.433 as being the correct value. An absolute determination made by Professor Carhart and Dr. Guthe had given a value of 1.4333, the last figure being in doubt. He is now having a more improved apparatus built, and will, within a few months, take up the work again, and also redetermine the electrochemical equivalent of silver. He has, however, made some comparative measurements of the Clark cell at fifteen degrees centigrade and the cadmium cell, using the saturated cadmium sulphate solution at twenty degrees centigrade. Their results gave a ratio of 1.4067. Professor Carhart then called attention to the case with which the cadmium cell can be constructed and the advantages of this as a standard of electromotive force, and he recommended that the Institute appoint a committee to draw up specifications for the cadmium cell, and that steps be taken with a view to securing action by the government to adopt the cadmium cell as a standard, provided Mr. Weston would dedicate it to the public. It was explained that this cell differs from the "Weston" cell, as in the latter the solution is saturated only at four degrees centigrade.

The discussion of this paper turned on the importance of the matter, and the resolutions were amended, providing that Professor Carhart's paper be printed and distributed to scientific bodies both in this country and abroad, inviting comment. The resolutions were adopted, with the understanding that the committee report to the Institute prior to the convening of the congress. It was suggested that credit should be given to Mr. Weston by designating the standard as the "Weston" cell.

Professor Kennelly made a statement in connection with the proposed congress, relating particularly to the desirability of adopting units of magnetomotive force and reluctance. He touched upon the unfortunate existence of the two sets of units, the absolute and so-called "practical." It had been thought desirable to abandon the practical units, but it was now too late. It had also been suggested to use the same names for the absolute units, prefixing the syllables "ab" or "abs" before them (for instance, "abvolt," "abs-ampere"). He pointed out that there are two sets of standards for engineering and for commercial work. The former should be international, and the latter may be local. It was thought also that it would be desirable to take up the question of a standard of light.

Dr. Goldsborough moved that Dr. Kennelly's paper be distributed with Professor Carhart's. This was agreed to.

Professor H. J. Ryan read a paper entitled "The Cathode Ray Alternating-Current Wave Indicator," which describes the use of the cathode ray for tracing current and electromotive-force waves. This paper will be printed in an early issue of the ELECTRICAL REVIEW.

The discussion of this paper pointed out the value of this apparatus in practical work. On motion of Dr. Goldsborough, a vote of thanks was tendered to Professor Ryan for his painstaking work in developing an apparatus of such great value.

A paper by Mr. A. W. K. Peirce, entitled "Some Notes on Certain Underground Hoisting Problems on the Witwatersrand," was read by title.

President Scott made a reference to the proposed engineering building. Four of the five associations mentioned by Mr. Carnegie in his gift have accepted the gift, and have each appointed three members of a general committee to consider plans and means. This committee has appointed a subcommittee, one from each organization, and the American Society of Civil Engineers, which has not yet taken definite action, has been invited to appoint a member who will take part in the conferences, pending action by that society.

Mr. J. G. White, on behalf of the Committee on Resolutions, offered resolutions thanking Mayor Hancock for his kind welcome to the city of Niagara Falls; the Local Committee, for the delightful entertainments and excursions which the

members had enjoyed; the Convention Committee, for the excellent programme, and the companies who had so generously contributed to their entertainment.

The meeting then adjourned, to meet the following morning in joint session with the Society for the Promotion of Engineering Education.

Thursday afternoon special trolley cars left the terminal station of the International Railway Company at three o'clock, making a trip to the Tonawanda substation of the Niagara Falls Power Company.

In the evening it had been planned to run special cars over the Great Gorge route, where the rapids would be illuminated by searchlights, but an unfortunate fire at a station on the road made the trip impossible.

BUFFALO DAY, JULY 3, 1903.

A joint meeting of the American Institute of Electrical Engineers and the Society for the Promotion of Engineering Education was held at 9.30 A. M. This meeting was called to order by President Scott, who introduced Professor Calvin M. Woodward, president of the society.

A paper was read by Professor W. S. Franklin, of Bethlehem, Pa., entitled "The Teaching of Physics to Engineering Students." The ultimate object of the teaching of physics to technical students is to lead the young man by a shortened route to that familiarity with physical things which is possessed by such a man as John Fritz. The shortening of the route which leads to this result depends upon the fact that the teacher of physics has to do largely with an epitome of real knowledge, and the primary object of physics is to develop in the young men's minds a logical structure consisting of an aggregate of conceptions and theories. Professor Franklin criticised those methods of teaching which apostrophize the wonders of Nature or which have the slightest speculative tendency.

The discussion of this paper showed a general agreement with Professor Franklin's ideas. It was pointed out by Professor Langsdorf, of St. Louis, that two methods should be recognized in laboratory work. In the first an equation is given to the student, which he must verify by experiment. In the latter the experimental work must be carried out first, and from the results obtained the equation for the curve must be deduced. In his opinion the latter method is the better.

Mr. J. G. White, of New York, read a paper entitled "The Problems that Are Facing the Electrical Engineer of To-day, and the Qualities of Mind and Character Which Are Needed to Meet Them." The qualities necessary in an engineer are originality, accuracy, quickness, thoroughness, lucidity, tactfulness and honesty. Emphasis was laid upon the necessity for correct speech and good manners, and it was urged that English be taught throughout the entire engineering course. The engineer should also have the use of at least one other modern language, and a thorough training in mathematics. The education of an engineer really begins after graduation, and this should be recognized as it is in other professions. It is more important to be able to master thoroughly one subject than to know much about many things. The best training for an engineer would be a thorough, broad college course, followed by three years in a technical school. Subjects for special attention would be English, arithmetic, particularly mental drill, algebra, physics, chemistry, electricity and magnetism, dynamo construction and ethics. Secondary subjects would be Latin, French, surveying and electrochemistry. Third should come Spanish or German and geology, and fourth, botany, zoology, logic, and mental and moral philosophy. He thought it necessary that the engineer should have some knowlege of business methods.

Professor Jackson read the paper contributed by Mr. B. Gherardi, Jr., upon "The Proper Qualifications of Electrical Engineering School Graduates, from the Telephone Engineer's Standpoint." While telephone engineering is a specialty, there is no need for special training, though it is desirable, if time allows, that telephone problems be taken up. The telephone engineer's general training should be such as to enable him to solve any problem, and no attempts should be made to teach data, to the neglect of other matters.

A paper by Mr. L. A. Osborne, upon "The Proper Qualifications of Electrical Engineering School Graduates, from the Manufacturer's Standpoint," was read by Mr. J. S. Peck. Mr. Osborne's experience had been that, while all the young men go through training for engineering, but few of them follow strictly engineering work, and not more than one in ten is fitted to take up this work successfully. On the other hand, there is a tendency of modern industries to demand technical training of men in its commercial departments.

In the discussion of these papers Dr. Goldsborough was not prepared to admit all that the practical men had said, and questioned whether they knew the conditions under which these courses were laid out.

Professors A. F. Ganz, F. C. Caldwell and others spoke of the great difficulty in laying out a satisfactory technical course, and the limited time, and said that suggestions as to what could be left out without loss in efficiency would be of much assistance.

Professor C. F. Allen made the point that the colleges were not turning out trained engineers, and that the young man must be given a chance to get some experience.

Professor Henry S. Carhart thought that differentiation should come in practice, and not in the schools, and that the principles should be taught in connection with the laboratory to give them points. The object should be to make an engineer, not a specialist.

Professor D. C. Jackson read a paper entitled "Typical Electrical Engineering Courses." Students have little power of thinking accurately, but the fault can not be laid on the secondary schools. The old method of training was better than the new, as it was thorough. An engineering course should include English, mathematics, drawing, chemistry, physics and mechanics, and then other things might be added to these. He criticised sharply superficial descriptive courses. The principles should be taught throughout, and it is necessary for the director of the technical course to be thoroughly familiar with proper pedagogical methods.

Mr. E. H. Mullin, of New York city, read a paper entitled "Training an Artist in the Forces of Nature." This pointed out some of the defects of technical education in the present day, and in answer to the question "How may the average man be trained for his profession?" Mr. Mullin said that we should teach methods, instill principles, and lay deep and sure the foundation of elementary knowledge, trusting the future to take care of itself. We have therefore two correlated branches of education to consider—education as an art, and education as a science. Education as an art involves perfect familiarity with a larger or smaller number of facts. We have to exercise the faculty of memory, and this memory must be clear and accurate. Having obtained the outlines through education as an art, the property of education is not to use them as we have been taught, but to apply them to new problems. Not only, therefore, is memory needed, but imagination.

Mr. T. J. Johnston read a paper entitled "Engineering English." In this Mr. Johnston criticised sharply the poor and often bad English found in technical writings, and made a strong plea for more

attention to the teaching of English in technical schools.

President Woodward expressed the pleasure that the Society for the Promotion of Engineering Education had had in holding a joint session with the American Institute of Electrical Engineers, to which President Scott replied that the pleasure was mutual.

On Friday afternoon, July 3, special trolley cars were provided for a trip to Buffalo, where visits of inspection were made at the terminal house of the Niagara-Buffalo Transmission Company, the substation of the Buffalo General Electric Company and the substation of the Buffalo Railway Company, all operated by Niagara power. Visits were also made to the central exchange of the Bell Telephone Company. For this run some of the new high-speed electric cars were provided, which can run at a speed of sixty miles an hour.

The convention was then declared adjourned.

Among those present at the convention were the following: C. F. Scott, Pittsburg, Pa.; R. W. Pope, New York; George F. Sever, New York; E. H. Mullin, New York; W. S. Barstow, New York; H. W. Buck, Niagara Falls, N. Y.; deL. Rankine, Niagara Falls; E. G. Acheson, Niagara Falls; B. J. Arnold, Chicago, Ill.; R. B. Owens, Montreal; C. J. Field, Brooklyn, N. Y.; Dr. W. E. Goldsborough, St. Louis, Mo.; G. A. Hamilton, Elizabeth, N. J.; Carl Hering, Philadelphia, Pa.; William R. C. Corson, Hartford, Ct.; William Hand Browne, Jr., New York; D. B. Rushmore, Pittsfield, Mass.; W. L. Waters, Milwaukee, Wis.; W. J. Jenks, New York; Elmer A. Sperry, Cleveland, Ohio; John F. Kelly, Pittsfield, Mass.; William J. Hammer, New York; William H. Wiley, New York; M. H. Gerry, Jr., Helena, Mont.; Charles S. Bradley, New York; George W. Davenport, Winchester, Mass.; Charles R. Huntley, Buffalo, N. Y.; J. G. White, New York; A. J. Wurts, Pittsburg, Pa.; G. E. Cox, Niagara Falls; George Urban, Jr., Buffalo, N. Y.; R. F. Hayward, Salt Lake City, Utah; William C. Woodward, Providence, R. I.; B. Abry, Pittsburg; A. H. Armstrong, Schenectady, N. Y.; Gano S. Dunn, Ampere, N. J.; W. L. R. Emmet, Schenectady, N. Y.; Cary T. Hutchinson, New York; P. M. Lincoln, Pittsburg, Pa.; Francis B. Crocker, New York; A. E. Kennelly, Cambridge, Mass.; C. E. Skinner, Pittsburg, Pa.; Calvert Townley, New York; Calvin M. Woodward, St. Louis, Mo.; H. A. Storrs, Denver, Col.; Joseph W. Richards, Bethlehem, Pa.; F. A. C. Perrine, Pittsfield, Mass.; C. A. Waldo, La Fayette, Ind.; Arthur N. Talbot, Urbana, Ill.; W. D. Weaver, New York; Frank G. Bolles, Cleveland, Ohio; D. B. Dean, Cleveland, Ohio; Henry S. Carhart, Ann Arbor, Mich.; Edwin R. Weeks, Kansas City, Mo.; Louis A. Ferguson, Chicago, Ill.; Ira O. Baker, Champaign, Ill.; A. A. Knudson, New York; F. L. Hutchinson, Milwaukee, Wis.

THE PACIFIC CABLE.

PRESIDENT ROOSEVELT SENDS FIRST MESSAGE TO GOVERNOR TAFT, MANILA, P. I., JULY 4.

Due to the energy and enterprise of Mr. Clarence H. Mackay, president of the Commercial Pacific Cable Company, and his associates, the cable joining San Francisco with Manila was completed and a message sent on July 4, the anniversary of the Declaration of Independence. Mr. Mackay's father, the late John W. Mackay, was the originator of the idea of the Pacific cable, and to him and his son the credit of this great enterprise is due.

The Commercial Pacific Cable Company was incorporated under the laws of New York on September 23, 1901, its charter authorizing it to lay and operate a submarine cable from California to the Philippine Islands by way of the Hawaiian Islands.

A series of soundings that had been made under the direction of the Navy Department, when it was thought that there was a possibility of the government constructing the cable, was placed at the disposal of Mr. Mackay's company. These recommended the route from San Francisco to the Hawaiian Islands, thence to Midway Island, Island of Guam and the Philippines. This route had four great sound stretches of 2,276, 1,254, 2,539 and 1,490 miles.

During the latter part of 1901, the late John W. Mackay made an offer to the government to lay a cable across the Pacific, without subsidy or guarantee of any kind and solely as a private enterprise. The Commercial Pacific Cable Company had meanwhile been incorporated and the contract for the first section of the cable, from San Francisco to Honolulu, awarded. This was to the India Rubber and Gutta Percha Works Company, of London, England. The cableship Silvertown with the first section of the cable, consisting of 2,413 nautical miles, on board, left the English coast on September 23, 1902, arriving at San Francisco on December 4. The shore ends of the cable were manufactured at the New Jersey works of the Okonite Company, Limited, of New York, and laid by the experts of that company at San Francisco, Honolulu, Manila and other points.

On December 15 the Silvertown left for Honolulu, arriving there on December 26. Meanwhile, on November 27, the steamship Ventura, with two cable hands and two splicers, under the direction of Mr. L. G. Martin, had left with the shore end, which was to be laid at Honolulu. By December 19, the cables were in from the offices to the cable-house and the splicing completed on December 22. The arrival of the cableship at Honolulu on December 26 was the occasion of great excitement and enthusiasm. On Sunday, December 27, the heavy shore end was laid, and on the morning of December 29 the ship buoyed this end up and went down to the deep-sea buoy. Owing to heavy weather, the shore end was not picked up and spliced on to the deep-sea end until January 1, and at 4 P. M. the cableship told Honolulu that the final splice was about to be commenced and to call San Francisco at nine o'clock.

A separate contract had been awarded to the Telegraph Construction and Maintenance Company for the remaining sections of the cable from Honolulu to Midway, Guam and the Philippines. On April 9 last, the cableships Colonia and Anglia left London with more than 6,000 miles of cable in their tanks. The Anglia arrived at Manila on May 22, and having landed the shore end on May 24, paid out cable through St. Bernardino Strait and on toward Guam. She arrived at Guam on June 4. The Colonia had proceeded direct to Guam, where she arrived on May 27, arriving at Midway on June 19, when communication between Midway and Guam was established. This left only the small section between Midway and Honolulu to be laid to complete the system. On the arrival of the Colonia at Midway, the Anglia proceeded from Midway to Honolulu.

As President Roosevelt is spending the summer at Oyster Bay, L. I., temporary headquarters had been established in one of the local village business houses. Mr. G. H. Usher, superintendent of the Postal Telegraph-Cable Company, was in charge of preparations for receiving the first message.

At twelve minutes past eleven o'clock President Roosevelt sent the following message to Governor Taft:

To Governor Taft,
Manila.

I open the American Pacific Cable with greetings to you and the people of the Philippines. THEODORE ROOSEVELT.

This message was immediately followed by a congratulatory note to Mr. Mackay as follows:

To Mr. Clarence H. Mackay,
President Pacific Cable Company.

Congratulations and success to the Pacific cable which the genius of your lamented father and your own enterprise made possible.

THEODORE ROOSEVELT.

These messages were followed by a number of congratulatory, official and ordinary despatches.

A section from Manila to Hong Kong is a part of the company's contract. This will be completed in the same manner and with the same rapidity as the section already finished.

A British Light Railway System.

By Our Special Correspondent.

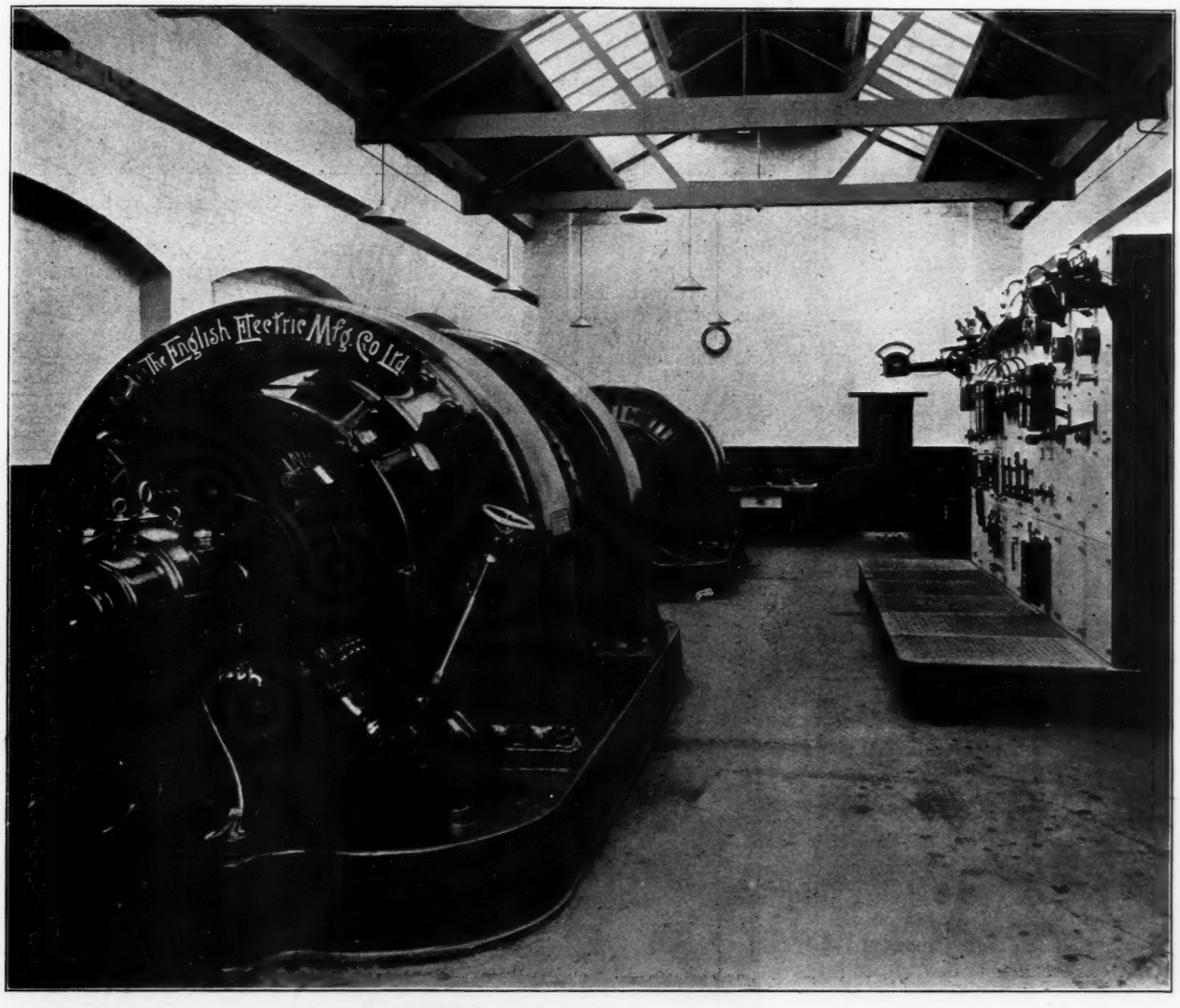
AN interesting system of tramways or light railways has recently been completed in the south of England, serving a purely country district. It is an addition to the very few examples we have here of electric trolley lines running on private as well as public roads and its electrical equipment is of more than ordinary interest. In a sense the line may be stated to be an actual extension of the Portsmouth municipal tramway system which was completed some months ago. It is owned by the Hampshire Light Railways Company, and an agreement has been entered into by which the Portsmouth corporation has undertaken to run a certain number of cars over the lines owned by the company.

The necessary electrical energy for the operation of the line is purchased from the Portsmouth Corporation, and the manner in which the joint arrangement has been carried out suggests that other country districts might be effectively linked up with town tramways, even when the two systems are operated by different authorities.

The commercial prospects of the line are excellent, and though in a sense it will be mainly patronized by pleasure-seekers, there is little doubt that it will be ultimately largely used by residents who, however, largely opposed the scheme, together with the railway companies.

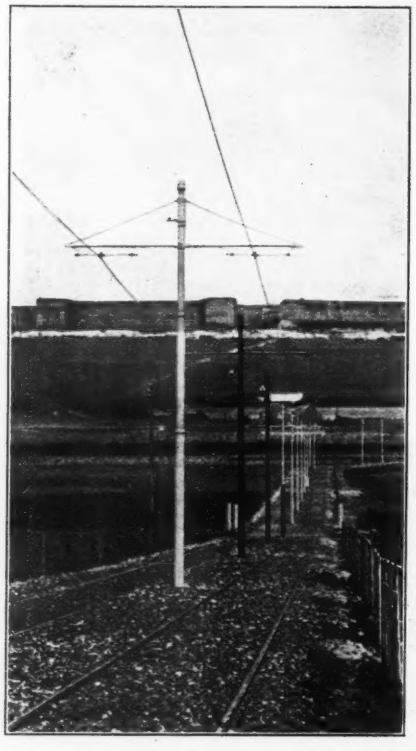
The length of line is six miles from the terminus at Cosham to the terminus at Horndean, and is of single line construction with passing places. The track is practically divided into three sections, owing to the different forms of construction rendered necessary by the nature of the country.

Section No. 1 from the junction with the Portsmouth Corporation Tramways to the top of Portsdown hill, is about one mile in length. This section presents all the features of ordinary railway construction, the line being taken across country some distance back from the county road, but parallel to it. There are three bridges in this section, one over the London & South Western Railway Company's line at Cosham, and two others over roads crossing the line of the track. About three-quarters of a mile of the track is carried on embankments, and the remaining one-quarter is carried through cuttings. The rails are laid



VIEW OF SUBSTATION, HAMPSHIRE LIGHT RAILWAYS SYSTEM.

on longitudinal concrete sleepers eighteen inches wide by twelve inches deep, and are kept to gauge by tie-bars spaced about every seven feet, the whole being ballasted up to the level of the rail-table. This construction is general for this section, except in places where the depth of the filling is considerable. In these instances the rails are supported on timber framing, the uprights of which extend right through the filling to a substantial concrete foundation. This form of construction being adopted to ensure the stability of the track should the filling material settle at any time.



A Portion of the Road, Hampshire Light Railways.

Section No. 2 from the junction with section No. 1 at the top of Portsdown hill, through the village of Purbrook to Waterlooville, is a distance of about two and one-half miles. This portion of the line is laid on the county road, and the form of construction is that of ordinary street tramway, that is, a foundation of six inches of concrete extending over the whole width of the track; the rails being laid on this foundation, and the whole tramway area paved with six-inch granite sets.

Section No. 3 from the junction with section No. 2 at Waterlooville to the terminus at Horndean is about two and one-half miles in length. This portion of the line is laid on the waste ground at the side of the county road, the construction of the track being exactly similar to that of section No. 2, that is, the rails are laid on the longitudinal concrete sleepers, and the whole being ballasted up to rail-table level.

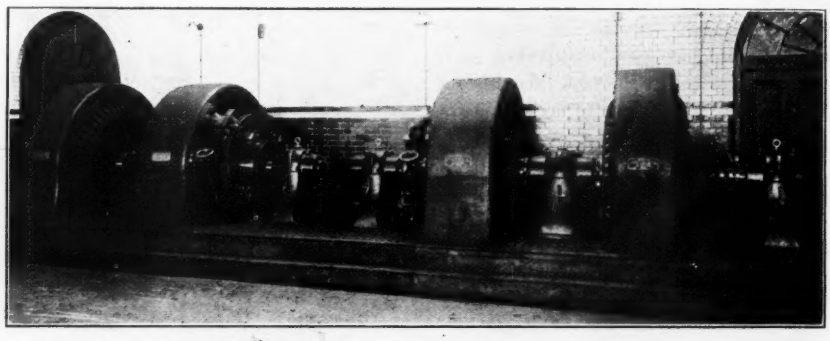
The rails used are of the ordinary grooved tramrail type, weighing ninety-six pounds to the yard, and are laid in lengths of forty-five feet with a percentage of shorter lengths to avoid cutting rails in the construction of the loops.

The overhead construction is somewhat unique, combining a special form of construction for light railway work with the ordinary form of bases, brackets, etc., for those parts of the line going through towns and villages. The system adopted is centre-running, the trolley wire which is No. 00 B. & S. gauge being in duplicate and carried over the centre of the track. Where double track exists centre-pole construction is adopted, and where the track is single, side poles with brackets are used, and on some parts of the line where the roadway is particularly wide the span wire system is in vogue.

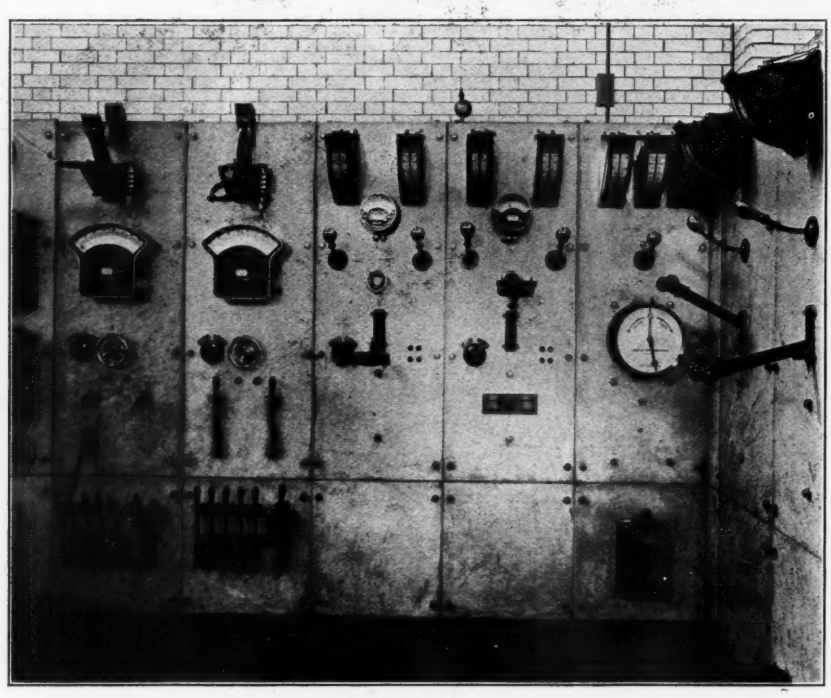
The type of brackets for light railway work, although plain in construction, is quite sightly, and particularly strong. The tie-rod supporting the bracket is held by a substantial malleable iron clamp on the top of the pole, the other end being attached to a combination flexible suspension bracket, and securely turned over the outside of the pipe, thus ensuring absolute rigidity for the bracket.

The trolley line is as usual divided into one-half-mile sections, a feeder pillar being erected at each place, having in addition to the usual four line switches a sufficient number of main switches to allow the main cables to be disconnected for making a loop test in case of breakdown.

The switches are mounted on marble panels, the holes being substantially bushed with ebonite and fitted in cast-iron pillars with water-tight doors. The trolley wire is supported by gun-metal hangers throughout. The insulation of



Motor-Generator Sets, Portsmouth Power-House, Hampshire Light Railways.



Extension of Switchboard at Main Power-House, Hampshire Light Railways.

the bolts supporting the wire being of specially moulded mica and capable of standing particularly high mechanical and electrical stresses. The ears are also made of a specially tough quality of gun-metal, varying in lengths from fifteen inches to twenty-four inches to suit the conditions of the work.

As the end of the line is a considerable distance from the Portsmouth power-house, the system necessarily called for transmission of energy at a high pressure.

The system of transmission is a three-phase one, three-phase motor-generators being at the tramway power-house in Portsmouth, whence current is transmitted at 6,000 volts to a substation about midway along the line.

There are two motor-generator sets which have been erected in the tramway works, each consisting of a four-pole direct-current shunt-wound motor, direct-coupled to an eight-pole three-phase alternator, carried on the same bed-plate. The motor derives its supply from the tramway bus-bars, and in consequence runs at 550 volts, and the output of each machine at 375 revolutions per minute is, on the alternating-current side, 250 kilowatts. The motor closely follows the standard practice adopted by Messrs. Dick, Kerr & Company, which have carried out the complete contract in their direct-current machinery. The armature is of the tramway slotted type; the windings being carried in slots. The armature core, which is built up of laminated discs, is carried on a cast-iron spider which is firmly keyed to the shaft, and the special construction of the spider permits of ample ventilation to the armature coils. The field yoke is of cast iron, the field magnets being built up of laminations and cast into the frame. The coils are wound on removable spools which are kept in position by a pole-shoe which also serves the purpose of properly distributing the magnetic flux.

The alternating-current generator having, as already stated, a capacity of 250 kilowatts when supplying current at 5,500 volts, is of the revolving field type, with external stationary armature. The stator consists of laminated segments, built up into a cast-iron frame, and special provision is made to give ample ventilation. The windings are carried in slots and connected up in star fashion. The field magnets, consisting of laminated steel, are carried on the revolving hub, which is itself keyed to the shaft.

Exciting current is led into the field magnet coils by means of two brass slip-rings, each slip-ring being provided with copper gauze brushes. The excitation of the fields of the alternator is obtained from a direct-current shunt-wound generator, which is coupled direct to the main shaft and carried inside one of the outer bearings. The details of the substation machinery are exactly in accord with the machinery at the main power-house.

The switchboard at the main power-house is connected to the already existing tramway switchboard, and is made up of five panels, carried on wrought-iron frames. On the motor panels are automatic circuit-breaker and illuminated dial ammeter, the necessary switches, motor starter and field rheostat. The generator panels, of which there are two, are provided with the necessary fuses and switches, field rheostat, field breaking switches and resistances, and synchronizing apparatus. The fifth panel is for the feeders, and controls the entire output of the motor-generator sets, and is provided with three high-tension fuses, one high-tension switch and Kelvin ammeter.

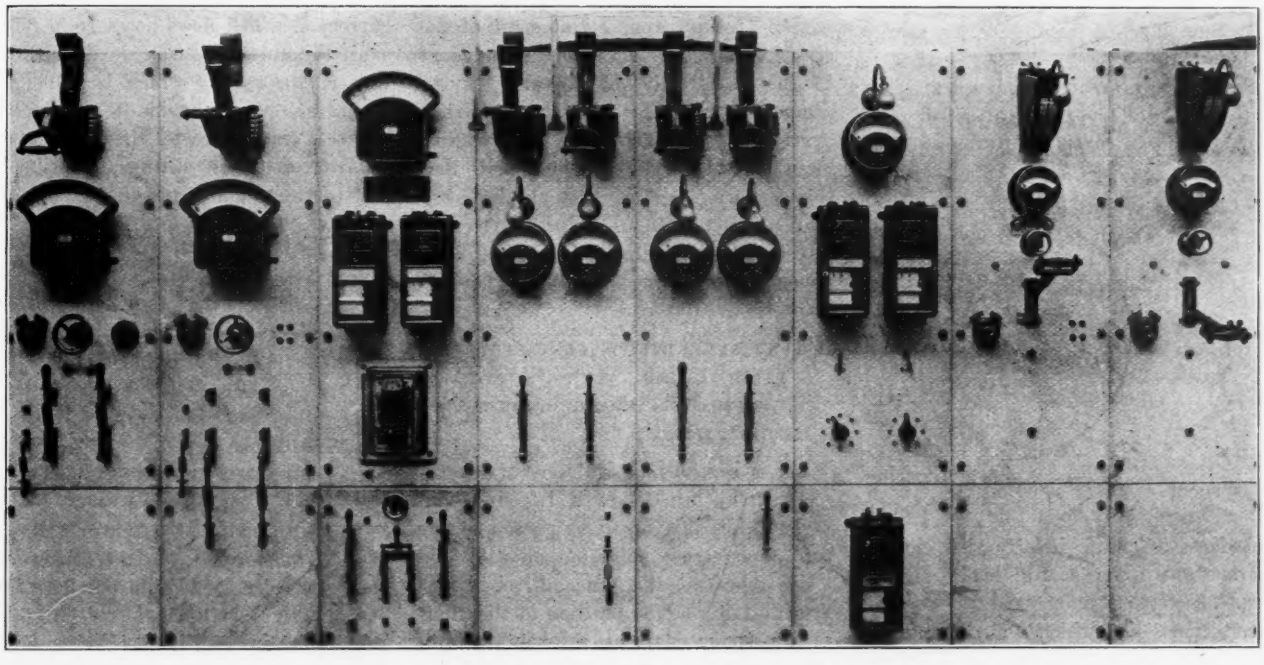
The switchboard at the substation consists of eight panels, the details of construction being similar to the board at the power-house. The input panel and two motor panels deal with current at 5,000 volts, and are arranged so that no live connections are accessible from the front of the board. They are provided with the usual ammeters and the necessary fuses and switches. The generator panels, which deal with the current for the overhead line, are provided with the usual equipment. There are, in addition, two feeder panels, and the ordinary board of trade panel.

The current is carried by a specially constructed three-core cable to the substation; the sectional area of each conductor in this cable is 0.05 square inch, and has a conductivity of over ninety-eight per cent according to Matthieson's standard. The cable is lead sheathed and under this lead sheathing is bound a copper earthing strip. The thickness of the dielectric between the cores is 0.1875 inch and between the core and the cable and the cable earthing strip 1.875 inches.

The insulation material used on the cables is specially impregnated paper, and so high is the insulation qualities of this that these cables which are in duplicate have stood an alternating electromotive force of 20,000 volts for fifteen minutes without the slightest defect becoming apparent.

From the substation a continuous current is taken to different parts of the line to cables of 0.5 and 0.25 square inch capacity, the whole of the cables being laid on the solid system. Thanks are due to Messrs. Dick, Kerr & Company for the material and illustrations contained in the above description. A. W.

London, June 27.



SWITCHBOARD AT SUBSTATION, HAMPSHIRE LIGHT RAILWAYS.

ENERGY TRANSFORMATIONS IN THE SYNCHRONOUS CONVERTER.[1]

BY WM. S. FRANKLIN.

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2. The synchronous converter compared with the autotransformer. Statement of object of this paper.
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9. The criterion of reality of component parts into which a physical aggregate is resolved by mathematical analysis.

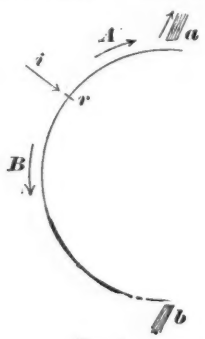


FIG. 1.

I—INTRODUCTION.

The engineer ordinarily approaches the study of the synchronous converter with ready-made knowledge of the direct-current dynamo and of the alternating-current dynamo. The result is that the action of the synchronous converter is usually described in terms of the activities of the synchronous alternating-current motor and the direct-current generator, and the theory of the synchronous converter is usually developed in terms of those notions which apply primarily to the synchronous alternating-current motor on the one hand and to the direct-current generator on the other. As a matter of fact, the external electrical relations of the synchronous converter may be completely represented by this method of attack. When, however, the synchronous converter itself—its internal activities, as it were—is the object of study, the notions of the synchronous alternating-current motor and of the direct-current generator do not suffice. There are certain elements of behavior of the synchronous converter which are foreign both to the synchronous alternating-current motor and to the direct-current generator; to examine into these elements we must attend to the actual physical activities of the synchronous converter without regard to the mathematical analysis of these activities into their more or less fictitious and unreal component parts, namely, synchronous motor activities and direct-current generator activities. I give in a subsequent section of this paper a statement of the criterion which enables one to judge of the physical reality or unreality of the component parts into which a physical aggregate is resolved by mathematical analysis, and it suffices here to state that this criterion shows the physical unreality of synchronous motor activity and direct-current generator activity as component parts of the activity of the synchronous converter.

II—THE SYNCHRONOUS CONVERTER COMPARED WITH THE AUTOTRANSFORMER. STATEMENT OF OBJECT OF THIS PAPER.

Let *b* Fig. 1 represent one of the direct-current brushes of a two-ring converter. Let this brush be chosen as the zero or reference point of potential, and let *a* represent the other direct-current brush. Let *r* be the position of the alternating-current tap at a given instant. This tap *r* is at a potential which is between the potentials of *b* and *a*. Let *i* be the instantaneous value of the alternating current entering at *r*. A portion, A, of this current *i* flows up hill, as it were, from *r* to *a*, receiving energy because of assistance due to the induced electromotive forces in the windings between *r* and *a*. Another portion, B, of the current *i* flows down hill from *r* to *b*, giving up energy because it is opposed by induced electromotive forces in the windings between *r* and *b*.

The energy received by the current A as it is boosted up from *r* to *a* is in general equal to the energy which is delivered by the current B which flows down from *r* to *b*.

Let *b*, Fig. 2, represent one of the service mains to which alternating current is supplied by an autotransformer. Let this main be chosen as the zero or reference point of potential, and let *a* represent the other service main. Let *r* and *r'* be the two supply mains. The main *r* is at a given instant at a potential which is between the potentials of *b* and *a*, and the current *i*, which enters at *r* at the given instant divides into two parts, A and B. The portion A flows up hill, as it were, to *a*, receiving energy because of assistance due to the induced electromotive forces in the windings between *r* and *a*. The other portion, B, flows down hill, from *r* to *b*, giving up energy because it is opposed by induced electromotive forces in the windings between *r* and *b*.

The energy received by the current A as it is boosted up from *r* to *a* is equal to the energy which is delivered by the current B which flows down from *r* to *b*.

In the autotransformer a definite portion of the energy which is transferred from the supply mains to the service mains is transferred by virtue of the conductive connections between supply mains and service mains through the windings

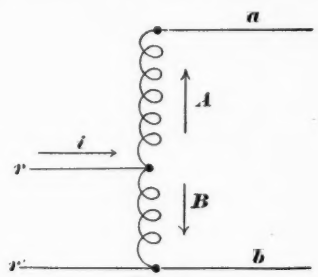


FIG. 2.

of the transformer. In the synchronous converter, also, a definite portion of the energy which is transferred from the supply mains to the service mains is transferred by virtue of the conductive connections through the armature windings of the converter.

In the autotransformer a definite portion of the energy which is transferred from the supply mains to the service mains is transferred by being inductively transformed from winding B, Fig. 2, which acts as a primary coil, to winding A, which acts as a secondary coil. In the synchronous converter a definite portion of the energy which is transferred from the supply mains to the service mains, is transferred by being inductively transformed from the portion B, Fig. 1, of the armature winding, which at the given instant acts as a motor, to the portion A of the armature winding, which at the given instant acts as a generator.

The object of this paper is to determine, of the total energy which flows through a synchronous converter, the fractional part which is conductively

[1] A paper presented at the twentieth annual convention of the American Institute of Electrical Engineers, Niagara Falls, N. Y., June 29 to July 3, 1903.

transferred from supply mains to service mains, and the fractional part which is inductively transformed. In case of the two-ring converter, the inductively transformed energy consists of two distinct parts, namely, (*a*) the energy which is transformed by simultaneous and balanced generator-motor action, and (*b*) the energy which is transformed by successive and unbalanced generator-motor action. These parts will be more fully discussed when we consider the problem of the two-ring converter.

III—THE MANY-RING CONVERTER.

Fig. 3 represents one side of a two-pole, many-ring converter. E is the electromotive force between the direct-current brushes *a* and *b*, I is the direct current entering at *a* and leaving at *b*, *i* is the current in the armature wires, at a point on the armature which is at angular distance β from brush *a*, and $d\,i$ is the value of the alternating current flowing out of all the collecting rings connected to commutator bars in the angular element $d\,\beta$ at the instant that these bars are at angular distance β from brush *a*. The arrows represent the directions in which the various electromotive forces and currents are considered as positive.

We shall assume here, as also in the discussion of the two-ring, the three-ring and the four-ring converters, that the converter receives alternating currents at unity power-factor, that alternating electromotive forces and currents are harmonic, and that the losses of energy in the converter are negligible.

Before proceeding to the consideration of energy transformations, it is necessary to determine the distribution of current in the armature for given direct-current output. From the above assumptions, we have:

$$d\,i = -\,\mathrm{A}\cos\beta\,.\,d\,\beta \qquad (1)$$

in which A is an undetermined constant. Integrating this equation we have

$$i = -\,\mathrm{A}\sin\beta + \mathrm{K} \qquad (2)$$

in which K is another undetermined constant. These constants A and K are determined by the following two conditions: 1. The generator and motor activities are at each instant balanced in the many-ring converter. 2. The alternating-current input of power is equal to the direct-current output of power. In order to formulate these two conditions it is necessary to find an expression for the generator (or motor) action in the element $d\,\beta$. Let $d\,e$ be the induced electromotive force in the element $d\,\beta$. Then it is easily shown on the basis of the above assumptions that

$$d\,e = \tfrac{1}{2}\,\mathrm{E}\sin\beta\,.\,d\,\beta \qquad (3)$$

Let d G be the generator action in watts (motor action if negative) in the element $d\,\beta$. Then $d\,\mathrm{G} = i\,.\,d\,e$, or

$$d\,\mathrm{G} = -\,\frac{\mathrm{E\,A.}}{2}\sin^2\beta\,.\,d\,\beta + \frac{\mathrm{E\,K.}}{2}\,.\,\sin\beta\,.\,d\,\beta \qquad (4)$$

The first condition above mentioned requires that the integral of d G from $\beta = 0$ to $\beta = \pi$ shall be equal to zero. That is:

$$\int_0^{\pi} -\,\mathrm{A}\sin^2\beta\,.\,d\,\beta + \mathrm{K}\sin\beta\,.\,d\,\beta = 0 \qquad (5)$$

which gives

$$\frac{\pi\,\mathrm{A}}{2} - 2\,\mathrm{K} = 0 \qquad (6)$$

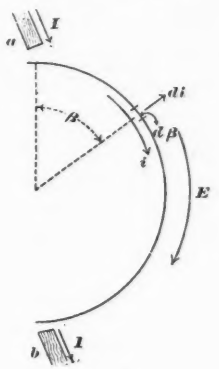


FIG. 3.

The alternating current intake of power in the half armature is

$$\tfrac{1}{2}\,\mathrm{E}\int_0^{\pi}(1 - \cos\beta)\,d\,i$$

and the direct-current output of power in the half armature is

$$\tfrac{1}{2}\,\mathrm{EI}$$

and these are equal, so that, using the value of $d\,i$ from equation (1), we have

$$\mathrm{I} - \int_0^{\pi}\mathrm{A}\cos^2\beta\,.\,d\,\beta - \mathrm{A}\cos\beta\,.\,d\,\beta = 0 \qquad (7)$$

which gives

$$\frac{\mathrm{I} - \pi\mathrm{A}}{2} = 0 \qquad (8)$$

Equations (6) and (8) determine the values of A and K, giving

$$\mathrm{A} = \frac{2\,\mathrm{I}}{\pi} \qquad (9)$$

$$\mathrm{K} = \frac{\mathrm{I}}{2} \qquad (10)$$

Using these values of A and K in equation (2) we have

$$i = \frac{\mathrm{I}}{2} - \frac{2\,\mathrm{I}}{\pi}\sin\beta \qquad (11)$$

It is worthy of note that the problem of the determination of armature currents in a synchronous converter is one which is properly based in every case on energy considerations, as in the above discussion.

We are now prepared to discuss the problem of energy transformations in the many-ring converter. Since the total generator action which is taking place at each instant in the many-ring converter is equal to the total motor action, therefore the inductively transformed power is equal to the total generator action (or to the total motor action). That is: the inductively transformed power, P, is equal to the integral of (4) over those portions of the armature where d G is positive. Now d G is positive where i is positive, since $d\,e$ is everywhere positive, and from equation (11) we find that i is negative from $\beta = 0$ to $\beta = 51^\circ.75$, positive from $\beta = 51^\circ.75$ to $\beta = 128^\circ.25$, and negative from $\beta = 128^\circ.25$ to $\beta = 180^\circ$. Therefore, attending to one-half of the armature and multiplying the result by two, we have:

$$\mathrm{P} = \mathrm{EI}\int_{\beta\,=\,51^\circ.75}^{\beta\,=\,128^\circ.25} -\,\frac{2}{\pi}\sin^2\beta\,.\,d\,\beta + \tfrac{1}{2}\sin\beta\,.\,d\,\beta \qquad (12)$$

which gives

$$\mathrm{P} = 0.1153\ \mathrm{EI} \qquad (13)$$

That is, 11½ per cent of the energy which flows through a many-ring converter is inductively transformed and 88½ per cent is conductively transferred from the alternating-current supply mains to the direct-current service mains.

Remarks—The activities of the two-ring, three-ring and four-ring converters are much more complicated than those of the many-ring converter. The wide separation of the alternating-current taps in the few-ring converter introduces pulsations in value of current and power in the various windings, as they pass a given point, so that in considering the internal actions of the few-ring converter, everything must be expressed as a function of time; and in the summation of generator and motor actions time integrations are involved.

IV—THE TWO-RING CONVERTER.

Fig. 4 represents one side of the armature of a two-pole two-ring converter; *r* is one of the alternating-current taps, *a* and *b* are the direct-current brushes, E is the electromotive force between direct-current brushes, I is the direct current flowing in at *a* and out at *b*, and i_a and i_b are the values of the currents in the armature parts as shown at instant *t*.

The arrows show the directions in which the various electromotive forces and currents are considered as positive.

The algebraic expressions for i_a and i_b are determined fundamentally by the same consideration of energy relations as in case of the many-ring converter. The expressions are:

$$\left.\begin{aligned} i &= \tfrac{1}{2}\,\mathrm{I} + \mathrm{I}\cos\omega t \\ i_b &= \tfrac{1}{2}\,\mathrm{I} - \mathrm{I}\cos\omega t \end{aligned}\right\} \quad (14)$$

Furthermore,

$$\left.\begin{aligned} &\text{Electromotive force between } a \text{ and } r \\ &\quad = \tfrac{1}{2}\,\mathrm{E}\,(1-\cos\omega t) \\ &\text{Electromotive force between } r \text{ and } b \\ &\quad = \tfrac{1}{2}\,\mathrm{E}\,(1+\cos\omega t) \end{aligned}\right\} \quad (15)$$

Let A be the generator action (motor action when negative), in watts between a and r; and let B be the generator action (motor action when negative), between r and b. Then

$$\mathrm{A} = \tfrac{1}{2}\,\mathrm{EI}\,(\tfrac{1}{2} + \tfrac{1}{2}\cos\omega t - \cos^2\omega t) \quad (16)$$

$$\mathrm{B} = \tfrac{1}{2}\,\mathrm{EI}\,(\tfrac{1}{2} - \tfrac{1}{2}\cos\omega t - \cos^2\omega t) \quad (17)$$

In case of the two-ring converter, the total generator action does not balance the total motor action at each instant and we must distinguish two parts in the inductively transformed power, namely, the power P which is transformed by simultaneous and balanced generator and motor action, and the power Q, which is first converted into kinetic energy as the armature is accelerated and afterward converted back into electrical energy as the armature is retarded.

The power P/2 (the division by two is on account of our considering one-half only of the armature) is equal to the integral of A during the time that A is positive, B negative, and A numerically less than B; plus the integral of B during the time that B is positive, A negative and B numerically less than A; minus the integral of A during the time that A is negative, B positive, and A numerically less than B; minus the integral of B during the time that B is negative, A positive, and B numerically less than A—these integrals being extended over half a cycle, and the final result divided by the duration of half a cycle. The value of P so found when divided by EI gives, of the total power which flows through the machine, the fractional part which is inductively transformed without passing through the intermediate stage of kinetic energy.

From equations (16) and (17) we find:

1. Generator action in $a\ r$ is less than motor action in $r\ b$ from $\omega t = 0$ to $\omega t = 45°$.

2. Generator action $a\ r$ is greater than motor action $r\ b$ from $\omega\,t = 45°$ to $\omega\,t = 60°$.

3. Generator action takes place in both $a\ r$ and $r\ b$ from $\omega\,t = 60°$ to $\omega\,t = 120°$.

4. Motor action in $a\ r$ is less than generator action in $r\ b$ from $\omega\,t = 120°$ to $\omega\,t = 135°$.

5. Motor action in $a\ r$ is greater than generator action in $r\ b$ from $\omega\,t = 135°$ to $\omega\,t = 180°$.

Therefore,

$$\mathrm{P} = \frac{2}{\pi}\int_0^{45°} \mathrm{A}\,.\,dx + \frac{2}{\pi}\int_{135°}^{180°} \mathrm{B}\,.\,dx - \frac{2}{\pi}\int_{120°}^{135°} \mathrm{A}\,.\,dx - \frac{2}{\pi}\int_{45°}^{60°} \mathrm{B}\,.\,dx \quad (18)$$

in which x is written for $\omega\,t$.

The numerical evaluation of the integrals in equation (18) gives:

$$\frac{\mathrm{P}}{\mathrm{EI}} = 0.09517 \quad (19)$$

That is, nine and one half per cent of the total energy which flows through a two-ring converter is inductively transformed by simultaneous and balanced generator and motor action.

The power Q/2 (division by two is on account of considering one-half only of the armature) is found by taking the integral of A + B during the time that this sum is positive, namely, from $\omega\,t = 45°$ to $\omega\,t = 135°$, and dividing the result by the duration of half a cycle. This gives

$$\frac{\mathrm{Q}}{\mathrm{EI}} = \frac{1}{\pi}\int_{45°}^{135°} (1 - 2\cos_2 x)\,dx = 0.3183 \quad (20)$$

That is, 31.8 per cent of the energy which flows through a two-ring converter is inductively transformed by successive and unbalanced generator and motor action.

From the above results, it follows that 58.65 per cent of the energy which flows through a two-ring converter is transferred from the alternating-current supply mains to the direct-current service mains by virtue of the conductive connections through the converter armature.

V—THE THREE-RING CONVERTER.

Fig. 5 shows one side of the armature of a two-pole three-ring converter, r' and r'' are two of the three alternating-current taps, a and b are the direct-current brushes, i_a, i_b and i_c are the values of the currents in the armature parts, as shown at instant t, E is the electromotive force between the direct-current brushes, and I is the steady current flowing in at a and out at b. The arrows show the direction in which the various quantities are considered positive.

The algebraic expressions for i_a, i_b and i_c are

$$\left.\begin{aligned} i_a &= \frac{\mathrm{I}}{2} - \frac{4\,\mathrm{I}}{3\sqrt{3}}\cos(\omega t - 150°) \\ i_b &= \frac{\mathrm{I}}{2} - \frac{4\,\mathrm{I}}{3\sqrt{3}}\cos(\omega t - 30°) \\ i_c &= \frac{\mathrm{I}}{2} - \frac{4\,\mathrm{I}}{3\sqrt{3}}\cos(\omega t + 90°) \end{aligned}\right\} \quad (21)$$

For present purposes, we need consider only the generator and motor actions which occur in the three armature parts, $a\ r'$, $r'r''$ and $r''b$, during one-third of a cycle, namely, from $\omega\,t = 0$ to $\omega\,t = 120°$. The integral of all the generator actions in these armature parts during this third of a cycle divided by the duration of the third of a cycle, gives one-half of the inductively transformed power P.

The electromotive forces involved are as follows:

Electromotive force between a and r'

$$= \tfrac{1}{2}\,\mathrm{E}\,(1 - \cos\omega t) \quad (22)$$

Electromotive force between r' and r''

$$= \frac{\sqrt{3}\,\mathrm{E}}{2}\cos(\omega t - 30°) \quad (23)$$

This equation is available only from $\omega\,t = 0$ to $\omega\,t = 60°$, since at the instant $\omega\,t = 60°$, r'' coincides with b and after this instant a portion of the section $r'\,r''$ is in the half armature which is out of consideration.

Electromotive force between r' and b

$$= \tfrac{1}{2}\,\mathrm{E}\,(1 + \cos\omega t) \quad (24)$$

This equation is used only during the interval from $\omega\,t = 60°$ to $\omega\,t = 120°$.

Electromotive force between r'' and b

$$= \tfrac{1}{2}\,\mathrm{E}\left[1 - \cos(\omega t - 60°)\right] \quad (25)$$

Let A, B′, B″ and C be the generator actions (motor actions when negative) in the armature parts $a\ r'$, $r'\ r''$, $r'\ b$ and $r''\ b$ respectively at instant t. Then we have:

$$\mathrm{A} = \tfrac{1}{2}\,\mathrm{E}\,(1 - \cos\omega t)\,.\,i_a \quad (26)$$

$$\mathrm{B}' = \frac{\sqrt{3}\,\mathrm{E}}{2}\,.\,\cos(\omega t - 30°)\,.\,i_b \quad (27)$$

$$\mathrm{B}'' = \tfrac{1}{2}\,\mathrm{E}\,(1 + \cos\omega t)\,.\,i_b \quad (28)$$

$$\mathrm{C} = \tfrac{1}{2}\,\mathrm{E}\left[1 - \cos(\omega t - 60°)\right].\,i_c \quad (29)$$

Equation (27) applies from $\omega\,t = 0$ to $\omega\,t = 60°$, and equation (28) applies from $\omega\,t = 60°$ to $\omega\,t = 120°$.

From equations (26) to (29) we find:

A is *positive* from $\omega t = 0$ to $\omega t = 100°.5$
A is *negative* from $\omega t = 100°.5$ to $\omega t = 120°$
B′ is *negative* all the time during which it applies
B″ is *negative* from $\omega t = 60°$ to $\omega t = 79°.5$
B″ is *positive* from $\omega t = 79°.5$ to $\omega t = 120°$
C is *positive* from $\omega t = 0$ to $\omega t = 60°$
Therefore

$$P = \frac{3}{\pi}\int_0^{100°.5} A \,.\, dx + \frac{3}{\pi}\int_{79°.5}^{120°} B'' \,.\, dx + \frac{3}{\pi}\int_0^{60°} C \,.\, dx \qquad (30)$$

Substituting the values of i_a, i_b and i_c from equation (21) in equations (26); (28) and (29), and the resulting values of A, B″ and C in equation (30) and integrating, we find:

$$P = 0.2358\ EI \qquad (31)$$

That is, 23.6 per cent of the energy which flows through a three-ring converter is inductively transformed by simultaneous and balanced generator and motor action, and the remainder, 76.4 per cent, is transferred from the supply mains to service mains by virtue of the conductive connections through the converter armature.

VI—THE FOUR-RING CONVERTER.

Fig. 6 shows one side of the armature of a two-pole four-ring converter, r' and r'' are two of the alternating-current taps, a and b the direct-current brushes, i_a, i_b and i_c are the values of the currents in the armature parts, as shown at the instant t, E is the electromotive force between the direct-current brushes, and I is the current flowing in at a and out at b. The arrows show the direction in which the various quantities are considered as positive.

The algebraic expressions for i_a, i_b and i_c are as follows:

$$\left.\begin{aligned} i_a &= \frac{I}{2} - \frac{I}{\sqrt{2}} \cdot \cos(\omega t - 135°) \\ i_b &= \frac{I}{2} - \frac{I}{\sqrt{2}} \cdot \cos(\omega t - 45°) \\ i_c &= \frac{I}{2} - \frac{I}{\sqrt{2}} \cdot \cos(\omega t + 45°) \end{aligned}\right\} \qquad (32)$$

Furthermore,
Electromotive force between a and r'
$= \frac{1}{2} E (1 - \cos \omega t)$ (33)
Electromotive force between r' and r''
$= E \cos(\omega t - 45°)$ (34)
Electromotive force between r'' and b
$= \frac{1}{2} E (1 - \sin \omega t)$ (35)

In the present case we need only consider the generator and motor actions which occur in the half armature during a quarter of a cycle, namely, from $\omega t = 0$ to $\omega t = 90°$. The integral of the generator actions in the three armature parts $a\,r'$, $r'\,r''$ and $r''\,b$ during the specified quarter of a cycle divided by the duration of a quarter cycle, gives one-half of the inductively transformed power P.

Let A, B and C be the generator actions (motor actions when negative) in

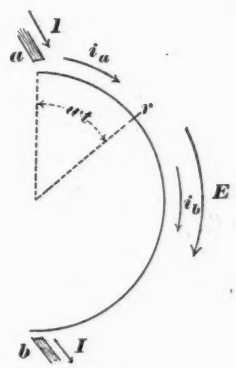


Fig. 4.

the armature parts $a\,r'$, $r'\,r''$ and $r''\,b$ respectively at instant t. Then we have:

$$A = \tfrac{1}{2} E (1 - \cos \omega t) \,.\, i_a \qquad (36)$$

$$B = \frac{E}{\sqrt{2}} \cdot \cos \omega t - 45°) \,.\, i_b \qquad (37)$$

$$C = \tfrac{1}{2} E (1 - \sin \omega t) \,.\, i_c \qquad (38)$$

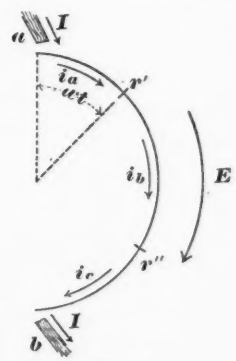


Fig. 5.

From these equations we find
A is *positive* from $\omega t = 0$ to $\omega t = 90°$.
B is *negative* from $\omega t = 0$ to $\omega t = 90°$.
C is *positive* from $\omega t = 0$ to $\omega t = 90°$.
Therefore,

$$P = \frac{4}{\pi}\int_0^{90°} A \,.\, dx + \frac{4}{\pi}\int_0^{90°} C \,.\, dx \qquad (39)$$

in which x is written for ωt.

Substituting the values of i_a and i_c from equations (32) in equations (36) and (38) and substituting the resulting values of A and C in equation (39) and integrating, we find

$$P = 0.1285\ EI \qquad (40)$$

That is, 12.9 per cent of the energy which flows through a four-ring converter is inductively transformed by simultaneous and balanced generator and motor action, and 87.1 per cent is conductively transferred from the supply mains to the service mains.

VII—SUMMARY.

ENERGY TRANSFORMATIONS IN THE SYNCHRONOUS CONVERTER.

Number of Rings.	Per Cent of Energy Transformed by Successive and Unbalanced Generator and Motor Action.	Per Cent of Energy Transformed by Simultaneous and Balanced Generator and Motor Action.	Per Cent of Energy Conductively Transferred.
2	31.83	9.517	58.65
3	0	23.58	76.42
4	0	12.85	87.15
Infinite	0	11.53	88.47

The calculation of these results demanded a great deal of painstaking computation; in fact, an amount which is very unusual in problems of this kind. These computations were done chiefly by Professor William Esty, to whom the author wishes to express his thanks.

VIII—ARMATURE REACTION OF THE MANY-RING CONVERTER AND ITS EFFECT IN DISTORTING THE ELECTROMOTIVE-FORCE CURVE OF THE MACHINE.

Consider the distribution of the magnetic field in the gap-space when the load on the converter is zero, and consider the distribution of field in the gap-space when the machine is delivering an amount of direct current I. Let f be the difference in value of these two fields at a point at angular distance β from the direct-current brush a, Fig. 3. Let $d\,f$ be the variation of f in the element of angle $d\,\beta$. Let l be the magnetic length of the gap-space in centimetres, n the number of armature conductors per centimetre of armature circumference, and let i be the current in the armature conductors at the element $d\,\beta$. Then from the fundamental relation between magnetomotive force and current turns, we have:

$$l \,.\, d\,f = \frac{4\pi.}{10} n\, i \,.\, d\,\beta$$

or

$$d\,f = \frac{4\pi n\, i}{10\, l} \cdot d\,\beta \qquad (41)$$

Substituting the value of i from equation (11) we have

$$df = \frac{2\pi n I}{10 l} \cdot d\beta - \frac{8 n I}{10 l} \cdot \sin\beta \, d\beta \qquad (42)$$

Integrating

$$f = \frac{2\pi n I \beta}{10 l} + \frac{8 n I \cos\beta}{10 l} + C \qquad (43)$$

In which C is a constant to be determined. By symmetry of winding and symmetry of distribution of current in two halves of armature, the value of f when $\beta = 0$ must be equal and opposite to the value of f, when $\beta = \pi$. Applying this condition to equation (43) we find:

$$C = -\frac{\pi^2 n I}{10 l} \qquad (44)$$

which substituted in equation (43) gives:

$$f = \frac{n I}{10 l} (2\pi\beta + 8\cos\beta - \pi^2) \qquad (45)$$

This equation holds good on one side only of the armature. For expressing the values of f on the other side of the armature, the angle β must be measured from the brush b, Fig. 3.

If the electromotive-force curve of the converter is determined by using an auxiliary concentrated winding of T turns of wire, then the amount by which the ordinate of the full load electromotive-force curve exceeds the corresponding ordinate of the zero load electromotive-force curve at the point β in volts is

$$e' = \frac{2 LT v n I}{l} \cdot (2\pi\beta + 8\cos\beta - \pi^2) \div 10^9 \qquad (46)$$

in which L is the length of the armature in centimetres and v is the peripheral velocity of the armature in centimetres per second.

If it is desired to cut away a layer of thickness x from the pole-face, so as to compensate for the armature reaction at full load, causing the machine to give the same electromotive-force curve at full load as it previously did at zero load, this may be done and the thickness x is a function of β. In fact

$$x = \frac{f}{B} \cdot l$$

in which B is the field intensity in the gap-space at zero load. Therefore

$$x = \frac{n I}{10 B} \cdot (2\pi\beta + 8\cos\beta - \pi^2) \qquad (47)$$

IX—THE CRITERION OF REALITY OF THE COMPONENT PARTS INTO WHICH A PHYSICAL AGGREGATE IS RESOLVED BY MATHEMATICAL ANALYSIS.

In the derivation of an algebraic expression for a determinate physical variable, two sets of conditions in general apply. 1. The condition or conditions which must be satisfied always and everywhere, that is throughout the interval of time and throughout the region of space over which the expression is to apply. These conditions are in most cases the requirements of the principle of the conservation of energy. 2*a*. The condition or conditions which must be satisfied at the boundary of the region. 2*b*. The condition or conditions which must be satisfied at the beginning of the time. Conditions 1 we will call persistent conditions. Conditions 2*a* may be persistent.

Consider as an example the problem of the vibration of an elastic string. The energy of the string is repeatedly transformed from kinetic to potential and back again, and the constancy of total energy is expressed by the well-known differential equation:

$$\frac{d^2 y}{d t^2} = -v^2 \frac{d^2 y}{d x^2} \qquad (a)$$

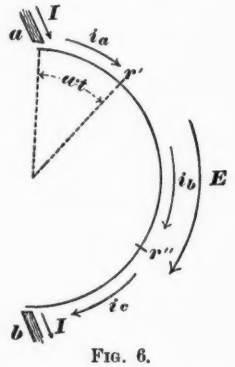


FIG. 6.

which must be always and everywhere satisfied.

At the ends of the string we have the persistent conditions,

$$y = 0 \text{ when } \left\{ \begin{array}{c} x = 0 \\ \text{or} \\ x = l \end{array} \right\} \qquad (b)$$

Any motion of the string is possible which satisfies these persistent conditions. Suppose that at the instant $t = 0$, the string is distorted into the shape represented by the equation,

$$y = f(x) \qquad (c)$$

The solution of the problem is

$$y = A \sin\frac{2\pi x}{l} + B \sin\frac{4\pi x}{l} + C \sin\frac{6\pi x}{l} + \cdots \qquad (d)$$

The various terms in this equation represent the component parts into which the actual motion of the string is resolved by the mathematical analysis of the problem. Each of these component parts satisfies all the persistent conditions of the problem and may therefore actually exist by itself, and there is no reason why we should not look upon each of these parts as real. In general the component parts into which a physical aggregate is resolved by mathematical analysis may be considered as real when each of these parts satisfies all of the persistent conditions of the problem and may exist alone.

Consider, as another example, the problem of the decay of current in an inductive circuit when the driving electromotive force is removed. Placing the rate of disappearance of electro-kinetic energy equal to the rate of generation of heat in the circuit, we have as a result the differential equation:

$$R i + L \frac{d i}{d t} = 0 \qquad (e)$$

which equation must be always satisfied. Furthermore, at the beginning, the current has a certain prescribed value I. That is:

$$i = I \text{ when } t = 0 \qquad (f)$$

The solution of this problem is

$$i = I\left(1 - t + \frac{t^2}{1'2} - \frac{t^3}{1'2'3} + \frac{t^4}{1'2'3'4} - \cdots\right) \qquad (g)$$

in which R/L has been placed equal to unity for brevity. The various terms in equation (g) represent component parts of the current i, these parts do not satisfy the conditions of the problem; they can not exist alone under the conditions of the problem, and therefore these parts can not be looked upon as physically real. In general, the component parts into which a physical aggregate is resolved by mathematical analysis can not be considered as real when they do not separately satisfy the persistent conditions of the problem and when these parts can not exist individually and separately under the conditions of the problem.

Consider the case of the polyphase synchronous converter after it is in full operation. The persistent condition is equality of inflow and outflow of electrical energy and constancy of kinetic energy of armature. The problem of the determination of armature current under these conditions leads to expressions—see equations (11), (14), (21) and (32)—which involve two terms. That is, the armature current is resolved into two parts and these parts correspond to inflowing alternating current and outflowing direct current, respectively. This correspondence strongly suggests the physical reality of these two parts of the armature current; but as a matter of fact, neither part of the armature current satisfies the conditions of the problem, neither part can exist alone under the conditions of the problem, and, therefore, these parts are mathematical fictions and not physical realities.

The Norwood, Ohio, Telephone Exchange.

By J. E. Peavey.

THE Norwood telephone exchange building, shown in Fig. 1, is one of three new suburban exchange buildings recently completed by the City & Suburban Telegraph Association, of Cincinnati, Ohio. These buildings, as shown, are two stories high, with a well lighted and ventilated basement. The outside is finished with red pressed brick and sandstone trimmings, and the roof is of red tile. All floors in the interior are of ferroconcrete construction, making the buildings absolutely fireproof.

Each of the buildings has an ultimate capacity of 4,800 subscribers lines, and 288 incoming and 280 outgoing trunks, the Western Electric standard common battery equipment being used throughout. The switchboards are located on the second floor, and when all of the sections are installed will be in a "U" shape, making operator supervision easy, as well as an attractive operating room.

The chief operator's desk is mounted on a slightly elevated platform, giving the operator in charge a clear and unobstructed view of the room and switchboard. This desk is equipped with two positions, each having ample line facilities and service-observing circuits. There is also a very conveniently arranged card system, readily furnishing the chief operator with data on any subscriber in the exchange.

On the first floor are located the main frames, relay racks, wire chief's desk, and a very comfortably appointed operators' quarters, consisting of locker room, with capacity for accommodating eighty operators, dining and sitting room, and kitchen and toilet room.

The power plant is located in the basement. At present there are eleven G-7 chloride accumulators in lead tanks, mounted individually on an elevated stand,

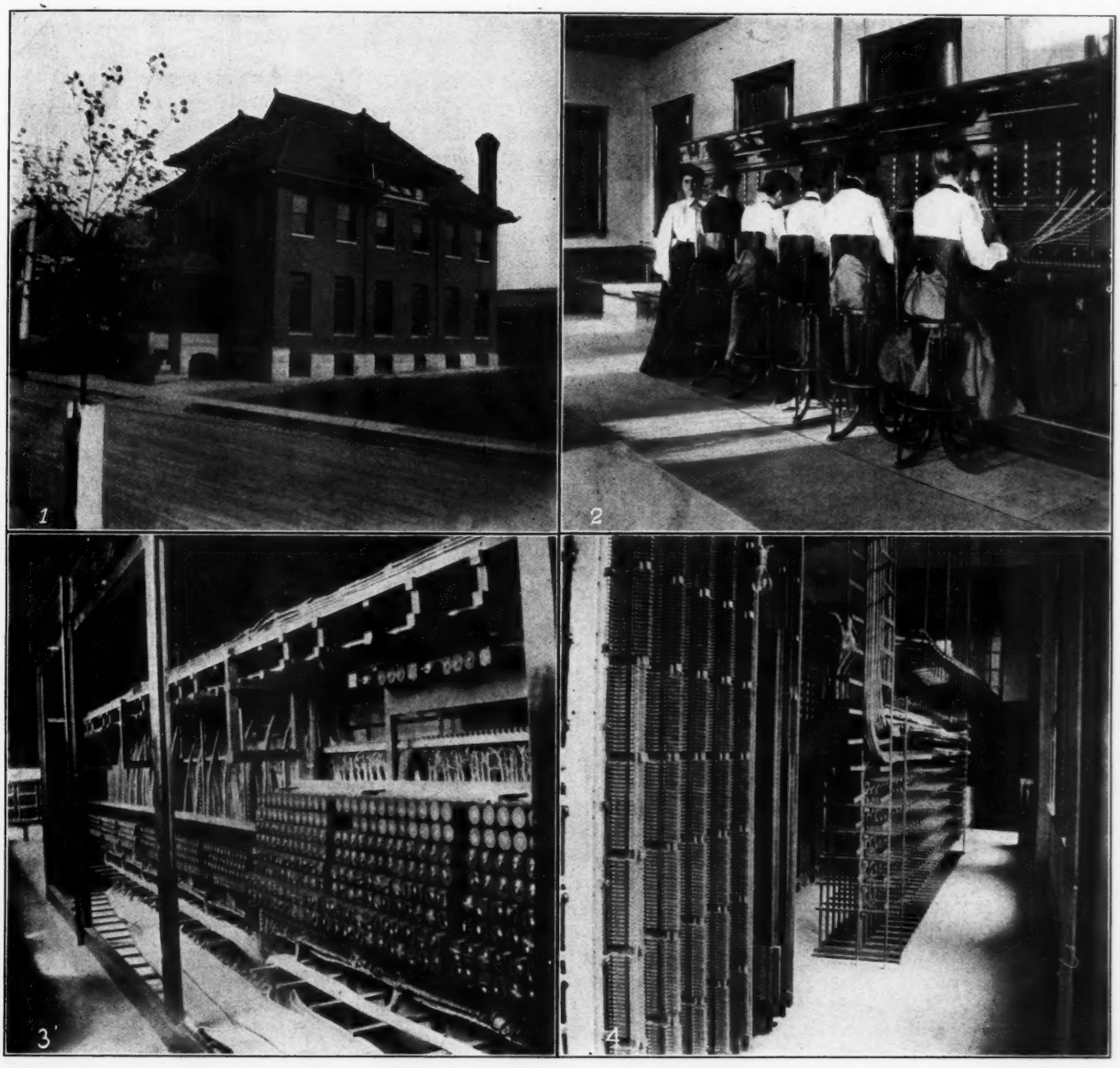


FIG. 1.—NORWOOD TELEPHONE EXCHANGE. FIG. 2.—FRONT OF BOARD. FIG. 3.—BACK OF BOARD. FIG. 4.—MAIN AND INTERMEDIATE FRAMES.

so that any tank may be lowered away from the plates in case the battery should be in need of repairs.

There are two dynamotor selective ringing machines, one motor-generator charging machine, and one charging generator belted to a Fairbanks & Morse gas engine, making the power almost infallible.

The power switchboard is finished in dark slate, with all wiring and apparatus artistically and neatly arranged.

Figs. 2 and 3 show a part of the front and back of the subscriber line switchboard, and Fig. 4 the main and intermediate frames. The Cincinnati Telephone Company's subscribers' list is increasing at the rate of about thirty-five per cent per annum, this being due principally to the untiring efforts on the part of the management to anticipate the needs, and give to the public the latest equipments and best service obtainable; and with all due consideration, it may truthfully be said that this company has no equal in the enjoyment of the confidence and good will of the public.

The officers are John Kilgour, president; B. L. Kilgour, general manager; R. T. McComas, assistant general manager.

The American Society for Testing Materials.

A committee recently appointed by the American Society for Testing Materials to investigate the subject of "The Magnetic Properties of Iron and Steel," met in New York city on June 26, to outline a series of investigations for the coming year.

This committee, which is headed by Professor J. Walter Esterline, of Purdue University, La Fayette, Ind., is composed of the following experts on the subject of iron and steel, and the results of its investigations will be of interest to electrical engineers, as well as those directly connected with the manufacture of magnetic materials: Dr. R. G. G. Moldenke, consulting metallurgist and chemist, Watchung, N. J.; Mr. J. A. Capp, chief of testing laboratory, General Electric Company, Schenectady, N. Y.; Mr. H. E. Diller, chief chemist, Western Electric Company, Chicago, Ill.; Mr. J. A. Mathews, metallurgist, Sanderson Brothers' Works, Crucible Steel Company of America, Syracuse, N. Y.; Mr. Robert B. Treat, engineer, Crocker-Wheeler Company, Ampere, N. J.; Mr. W. A. Layman, general manager, Wagner Electric Manufacturing Company, St. Louis, Mo.

The committee made its first report at the annual meeting of the American Society for Testing Materials, at Delaware Water Gap, July 1, 1903, and the results of the investigations will be announced at the annual meeting in 1904.

ALTERNATING-CURRENT MOTORS FOR VARIABLE SPEED.[1]

BY W. I. SLICHTER.

1. The impression is very general that a variable speed can not be obtained with an alternating-current motor, and that if an alternating-current plant is to be installed, the idea of obtaining a variable speed drive of any of the tools must be abandoned. That is not so, and the object of this paper is to show the possibilities of this type of motor, and to point out its limitations.

But it must be understood in the first place that it is not claimed for the alternating-current motor that it can compete with the direct-current type where continual variations of speed, throughout a wide range, are required, as the latter motor is usually superior in efficiency under these conditions.

2. Let us assume, then, that the problem to be solved is a case where an alternating-current plant is desirable for general reasons, such as distance of transmission or availability of power, and that a considerable amount of the power is used in constant speed work, but a certain portion of the work requires a variable speed. What is the most appropriate and most efficient method of obtaining the variable speed?

3. The speed of an alternating-current motor may be controlled in a number of ways:

(*a*) By varying the potential applied to the primary of a motor having a suitable resistance in the secondary.

(*b*) By varying the resistance in the secondary circuit.

(*c*) By changing the connections of the primary in a manner to change the number of poles.

(*d*) By varying the frequency of the applied voltage.

For the benefit of those not familiar with the polyphase induction motor, a general view of its characteristics may be desirable.

4. These characteristics are very similar to those of the continuous-current shunt motor—that is, at a constant impressed voltage and frequency the speed tends to be constant, and a considerable change in load will not cause an appreciable change in speed. As the load increases, the speed drops gradually to a critical point, usually about fifteen to twenty per cent below the normal value, and then the motor breaks down completely if the load is any further increased. The same action occurs exactly if the load is kept constant and the voltage is decreased. But if the frequency of alternation of the impressed voltage is decreased, the speed will decrease in exactly the same proportion. That is, for a given frequency and a given number of poles in the motor, the speed is practically fixed and independent of all other effects.

5. The drop in speed from the synchronous value is directly proportional to these losses. Thus, by increasing the resistance of this circuit, any desired speed may be obtained at the expense of these losses. With the increased resistance, the speed at which the motor breaks down may be reduced to a very low value, even to zero speed. Thus, by reducing the voltage applied to the motor for a given torque, the effect is produced of overloading it, and the speed drops.

6. In this connection it should be remembered that a variation of an alternating voltage may be obtained by means of a reactance or compensator with a very small loss of energy, whereas with a continuous voltage the loss of energy is usually proportional to the variation in voltage.

7. Potential Control—In this a suitable reactance or "compensator" reduces the line voltage to the fractional value desired. In this reduction the energy lost is only about five per cent of the amount transformed.

The induction motor should have a very large resistance in the secondary, which is preferably of the squirrel-cage type. This resistance gives the motor a speed characteristic such that its full load speed is some ten per cent less than that of a normal motor, and as the load is increased, the speed will fall to about thirty per cent of this value without the motor "breaking down" or falling out of step, which in the normal motor usually takes place at about eighty per cent of the full load speed.

8. Such a motor would have the following characteristics, assuming its synchronous speed as 100, and the voltage applied as 100. (This is based on a fifty-horse-power, forty-cycle motor, at 800 revolutions per minute, as an instance.)

For constant full load (fifty horsepower) torque at various speeds:

	Speed.	Volts.	Efficiency.	Losses, Motor. Kilowatts.	Kilowatt Compensator. Kilowatts.
Full load speed.....	.89	100	81	8.8	0.0
Three-quarter load speed.....	.67	66	59	18.5	1.0
One-half load speed	.45	57	37	32.0	2.0
One-quarter load speed.....	.22	56	17	45.7	3.5
Normal motor (full speed).....	.98	100	88	5.0	0.0

[1] Abstract of a paper presented at the Saratoga meeting (June, 1903) of the American Society of Mechanical Engineers.

9. Rheostat Control—In this scheme the secondary or rotor must have a definite winding (as opposed to the squirrel-cage, which is cheaper) with slip rings and brushes to lead out the current. The friction and resistance losses due to these brushes decrease the efficiency of the motor somewhat. The secondary is usually wound for a higher voltage and less current than in the standard or normal motor, to minimize these losses. The action of this method is based on the principal that, in an induction motor, the drop in speed for any given torque is proportional to the resistance of the secondary circuit.

10. This scheme would show the following characteristics for the same motor as before at fifty-horse-power torque, constant:

	Speed.	Volts.	Efficiency.	Losses, Motor. Kilowatts.	Rheostat. Kilowatts.
Full load speed.....	.96	100	86	5	0.0
Three-quarter load speed..	.72	100	65	5	9.0
One-half load speed.....	.48	100	43	5	18.5
One-quarter load speed....	.24	100	22	5	28.0
Normal motor (full).....	.98	100	88	5	0.0

As will be seen, this method gives a higher efficiency throughout, but particularly excels the previous method in having so much smaller losses in the motor itself, thus permitting of a smaller design and less danger of damage. The losses are concentrated in a rheostat, which is a cheaper piece of apparatus and less liable to damage, being of iron and asbestos usually, instead of high grade insulating materials, as in the motor proper.

11. Changeable Poles—By using a pitch of winding which is commensurable with two numbers of poles, we may build a motor which will operate with either four or eight, six or twelve, etc., poles, by a slight change of the connection. Or by a more intricate arrangement of windings a change from four to six, six to eight, etc., may be made.

In this arrangement it is necessary to use a squirrel-cage armature, since it is suitable for any number of poles, and the pitch of the primary coils has to be made some compromise value between the normal pitch of the two combinations, so it is usually not the best or most effective pitch for either number of poles. Therefore the constants of this motor should not be expected to be as good as those of the standard motor.

12. For a motor operating at full and half speeds, say with six and twelve poles for 800 and 400 revolutions, we would have:

	Volts.	Efficiency.	Losses.
Full speed, 50 horse-power.	100	86	5.8
Half speed, 25 horse-power.	100	74	0.6

Thus, for full load torque at half speed we get an efficiency almost double that obtained with the other methods, but what losses there are are in the motor itself, as in the first case. The losses are about the same in the two cases, the speed and thus the ventilation being half in one case, the heating is greater at the lower speed.

13. Variable Frequency—Every induction motor tends to run at synchronous speed—that is, at a speed equal to

$$\frac{60 \times \text{frequency}}{\frac{\text{Poles}}{2}}$$

Thus, if a different frequency is impressed on the motor, it will run at a different speed. Some installations have been made where two or three alternating-current generators are used to obtain different frequencies, and these circuits are carried around the shops by various sets of lines (usually three in each set) and the motor connected to the lines giving the frequency and speed desired. For normal losses in the iron the voltage must vary with the frequency. Thus for full and half speed we have:

	Volts.	Efficiency.	Losses.
Full speed, 50 horse-power.	100	88	5
Half speed, 25 horse-power.	50	87	2.8

14. Generators have been built having two stationary armatures in the same frame and two revolving fields, with a different number of poles on the same shaft to give the multiple frequency desired. An application of this principle, which is very pretty theoretically, is that of a very small variable speed induction motor (whose losses are negligible) which drives a commutator feeding the primary of the load machine; by a suitable control of the little motor any desired frequency may be supplied to the lead machine from zero to full value, thus it may be started and run at any desired speed. A variation of this is to attach the commutator to the shaft of the load machine and the brushes to the shaft of the controlling motor, thus when the load machine is standing still the brushes revolve at almost full speed on the commutator, and a very low frequency is obtained in the commutated circuit. As the load machine speeds up, the difference in the speeds of the commutator and the brushes decreases, and hence the frequency increases until that time when the commutator and brushes are revolving together at the same speed when there is no commutation and the load machine receives full frequency.

15. Summary—From these descriptions it will be seen that the changeable pole and variable frequency methods are the most efficient, but do not permit of a variation through a wide range of speed. The rheostatic control is the simplest and easiest of control, giving a range from standstill to full speed, but is not as efficient as the first two, although more efficient than potential control. The last mentioned has the disadvantages of low efficiency and considerably increased heating in the motor itself, and is also unstable at low speeds, say below one-third speed. That is, a small variation in torque or a smaller variation in voltage will cause a considerable variation in speed.

16. The potential control is used where moderate variations in speed are wanted, not reaching to less than half speed for instance, and where the load is intermittent, not giving the motor a chance to get too hot. Its great disadvantage is the amount of current it takes at starting, which causes considerable disturbance in the supply circuit, flickering of lights, etc., due to the drop in voltage. The motor used is a cheaper one to build (for the same size) than the others, but if anything like continuous running is desired, the motor must be larger, thus much of this advantage is lost.

17. One advantage of this motor is that it may be totally enclosed for use in powder mills, oil refineries or where much dust or corrosive vapor is encountered, as it may be controlled from a distance without increasing the number of wires.

18. The rheostatic method is particularly adapted where frequent starting and low speeds are required, as it causes no unusual drain on the supply system when starting. Thus it is used for hoists, elevators, etc.

The changeable pole system has the same disadvantages in starting as the potential control. For long-continued running at only two different speeds it is excellent, and has constants comparable with those of a continuous-current motor.

19. To vary the frequency of alternation for the motor requires an increased investment in generating station or auxiliary apparatus and line copper, and the greater the number of speeds desired, the greater this complication; but in its action and economy it is equal to any.

One point which is important to bring out is that with the changeable pole and changeable frequency systems the motor will not vary appreciably from the set speed for changes of load, while with either potential or rheostatic control, a change of load will cause an appreciable variation from the desired speed, requiring a readjustment of the potential or resistance to bring the speed to the desired value again.

Notes from Great Britain.

By Our Special Correspondent.

THE 1903 parliamentary session which is now well on its way toward conclusion has, despite the suspension of all the bills dealing with "tube" railways in London, raised many hitherto undebated points, and many matters which have been fought out in previous sessions have been argued, with opposite results this year. One of the most important of the latter is in connection with the large electric power supply companies. Previous to this year it has been the general custom to exclude from the areas asked for by the companies all large towns already owning electricity supply works, but this session, on the only two bills of the kind which were opposed, the committee decreed oppositely to this, on certain conditions, of course. The two companies in question scheduled large areas in Somersetshire and in the Northwest Midlands, and the parliamentary committees dealing with the bills have set up a precedent which will be largely relied upon in the future, *viz.*, that the company shall not supply any town already owning an electricity works except with the consent of the municipality, but should such consent be unreasonably withheld an appeal may be made to the Board of Trade. The general feeling is that this attitude of Parliament—which, however, may be reversed when the bills come before the House of Commons—is all for the good of the industry, as the already authorized distributors of electricity will always have the possibility of the big company under some pretence or another, appealing to the Board of Trade as to why they should not be allowed to supply any of those particular places. Another matter of somewhat new import, is the sanction to run a service of trolley omnibuses, without rails, in Somersetshire in connection with a system of electric tramways. The idea is to carry on such a service in those less populated portions of the country where the traffic, for the present, is not likely to be very large. The experiment will be watched with interest outside Great Britain, but I believe the promoters have not gone into the details of that part of the scheme yet. Then, again, that much debated question of municipal trading has been largely to the fore in relation to electrical matters. The gas companies, whose undertakings are heavily assessed by the local authority within whose boundaries they are situated, now come before Parliament with the argument that being ratepayers some restriction should be placed upon municipal trading in a commodity—such as the electric light—which is in direct competition with themselves, as in the event of a loss, the deficit upon such competitors' undertakings has, in part, to be made up, per its share of increased rates, by the gas companies. So forcibly has the argument been put before Parliament, that in two instances clauses have been inserted specifying that if, after the first year's working of the municipal undertaking, a loss is declared, the prices shall be increased so as to prevent a loss in future years. It may also be interesting here to note that a joint committee of the houses of Lords and Commons has been selected to consider the whole question of municipal trading. These constitute the main points of electrical interest which have arisen in connection with the year's bills, and it will be interesting to revert to them when they have been dealt with in the House of Commons.

The Wolverhampton Town Council has, after a year's working of some eleven miles of surface contact tramways, come to the conclusion that, mainly on the score of expense, they are unsuitable, and has ordered its consulting electrical engineer to prepare a scheme of overhead electric lines for the borough. This is the only instance of its kind in Great Britain, and whereas both the corporation and the Lorain Steel Company, whose system was adopted, are now being blamed for entering into an agreement of the nature of the one which was entered into, it must be said that it is only now for the first time that the terms of the said agreement have been made public, so that the press had no opportunity of commenting upon this part of the arrangements before. The complaint of the corporation is that it had been misled as to the cost of the working expenses of the system, which, for the electrical energy required alone, worked out at one penny per car mile extra to the average cost for the overhead trolley system here, and the total extra cost per annum over the overhead system for the eleven miles in Wolverhampton is put at nearly £6,000. The attitude of the local authority, therefore, was that looking at these figures in the light of the heavy rates of the borough, the cheapest system of traction, consistent with reasonable safety, should be adopted. The resolution to terminate the agreement with the company was therefore passed, and a subcommittee was appointed to settle the affair up. Unfortunately, the company will be the heaviest loser in the matter, as by the agrement with the corporation that if the tramways, among a list of things, did not prove commercially successful, it would, upon receipt of notice from the corporation, remove all feeder pillars and contact boxes, and reinstate and make good all paving in connection with the tramways, but leaving all cables, and connections laid under the roadways in possession of the corporation, no payment whatever being made by the corporation. It was a sporting offer on the part of the company, but British local authorities, when an opportunity arises for getting something for nothing, are apt to forget to look at things from all points.

The details of the electrical equipment of the North-Eastern Railway Company's lines are being gradually evolved, and the following is some information of what has been decided upon up to date: A single conductor is to be placed in the six-foot way with a return by way of the running rails, current being supplied to the lines at 600 volts continuous. The conductor rail will be of steel, and will weigh eighty pounds per yard, being carried on granite insulators. The Newcastle-on-Tyne Electric Supply Company, which will supply the necessary electrical energy to the railway company, at first intended to supply from its existing generating station, but its general supply business has so largely increased that this has been found to be impossible, and a new power-house will be erected. In this new generating station, the generating plant will be a number of 3,500-kilowatt Parsons turbo-generators, supplying three-phase current at 6,000 volts pressure and forty cycles per second. This current will be supplied to five substations, in which will be situated fourteen 800-kilowatt rotary converters. The train coaches, the bodies of which will be made by the railway company's own workmen, will be fitted with the British Thomson-Houston multiple unit systems of control. Motor coaches will be at each end of the trains, and each will be equip-

ped with two 150-horse-power G.-E. motors, both being carried on one bogie truck. Four contact shoes will be fitted to each motor car. For the goods service, electric locomotives are to be employed. The British Thomson-Houston Company has the contract for the electrical equipment of the rolling stock and permanent way, the British Westinghouse Company that for the complete equipment of the substations, and Messrs. Siemens Brothers & Company that for the three-phase high-tension, telephone, and pilot cables. Although in no way precisely comparable with the Mersey railway, yet in some directions it may be so compared, and from that point of view the experience gained on the Mersey railway may be useful. But as a perfectly open surface steam railway converted to electrical working, it will afford great interest, especially in view of the possible adoption of electric traction on the main steam lines of the country.

There have been many discussions in Parliament upon the, to some minds, unsatisfactory condition of the postal-telegraph system of Great Britain, but the one which took place in the House of Commons a short time ago was about as comprehensive an affair as has taken place for some time. The occasion was afforded by the proposal to vote a large sum of money for telegraph purposes, and in the debate the faults of the Post Office Department were freely discussed. In the first place, attention was once more drawn to that £1,000,000 loss last year on the telegraph system of the country; then was asked the question as to why the government did not negotiate for the purchase of the submarine cables in connection with Great Britain; this was followed by complaints of the present high tariffs for submarine cable messages, as well as the high rates for telephonic communication between Great Britain and the continent, and on the trunk lines generally. Finally, great indignation was expressed as to the manner in which the government had treated Mr. Marconi in connection with his system of wireless telegraphy. These are quite a sufficient quantity of queries for the Postmaster-General to have to answer "at one go," and it is quite as well that government officials as a rule do not take these trifles too seriously. All the questions enumerated above, be it mentioned, were put by that champion of telegraphic and postal reform, Mr. Henniker Heaton. Among questions put by other speakers was one as to the results of the international telegraph conference, about which a good many would be glad to hear something. Mr. Austen Chamberlain, the Postmaster-General, replying on behalf of the government, dealt seriatem with the queries put to him. The large deficit on the telegraph system he attributed to a variety of causes. He considered the state had paid an exorbitant price when it bought the telegraphs from the old companies, a price which forestalled profit, and exceeded any profits which could be fairly taken into account at the time of the purchase. In addition to this, there had been in recent years repeated demands for concessions to the public, and also for increased salaries to the telegraph employés. It was obvious, he concluded, that with all these forces at work profits could hardly be expected. He hoped to make some reforms however. With the purchase of cables he did not deal, but in connection with the reduction of rates, he pointed out that foreign administrations had to be dealt with, which increased the difficulties, but as a result of the international telegraph conference he hoped to be able to announce some further reductions. Coming to the question of wireless telegraphy, he repudiated the suggestion that the Post Office was trying to stifle that invention. What had been done was to avoid giving away the rights of the Post Office in the way that they had been parted with in the case of telephones to the National Telephone Company. The Marconi Company had not merely asked for the rights at present accorded to the cable companies, but wanted exclusive permanent rights, which he could not give them. In connection with the Post Office telephone system he said that there were now laid in London about 100,000 miles of cables. The greater part of the licenses of the National Telephone Company expired in 1911, and, from past experience, he could never imagine any government would ever allow the service to pass out of its hands. Finally, he dealt briefly with the international telegraph conference. He said this was mainly concerned with the domestic details of the telephonic administration of the world, which was not a very fit subject for public discussion. But with the question of the compulsory adoption of the Berne vocabulary, he felt so convinced of its inconvenience and disadvantage that he had instructed the British delegates to oppose it.

A short time ago announcement was made of the formation of a new scientific society, known as the Society of Electro-chemists. The name of this has now been changed to the Faraday Society, for the promotion of the study of electro-chemistry, electrometallurgy, chemical physics, metallography and kindred subjects. The first president is Mr. J. W. Swan, and in order that the work of the society may not be too long delayed, a meeting was fixed for June 30, and a half session will then be commenced. It may also be mentioned that arrangements are being made for the free distribution to the members of the Faraday Society of the transactions of the American Electro-chemical Society.

Very little has been heard for some time of the mono-rail scheme between Liverpool and Manchester, which Parliament sanctioned a couple of years ago, and like many another similar project, it has soon been forgotten by the public. There have been several reasons why the particular scheme mentioned above has not been yet matured beyond the completion of the surveys, the most important being the inability to raise the capital. The Board of Trade also desired that an experimental length should at first be constructed, in order to demonstrate the safety of the system. To this latter condition the promoters have agreed. Finding money for electrical undertakings of so speculative a character as this one must naturally be a difficult matter, but a separate company has been formed, consisting mostly of stock exchange men, expressly for financing this scheme in particular and similar schemes in general. Ever since the year when Parliament sanctioned the Manchester-Liverpool line, the inventor of the system, Mr. Behr, has lost no opportunity of expounding the merits of the principle, and he has succeeded in convincing a number of eminent engineers. For instance, Sir Frederick Bramwell fully supports the contention that derailment is impossible, and even goes so far as to say that as regards speed and comfort, the mono-rail is far ahead of the two-rail line. Again, Sir William Preece is of the opinion that the idea reduces the cause of accidents on ordinary lines to a minimum. The only experience of such a railway is the experimental line at Brussels, where eighty-three miles an hour has been attained on curves. The Liverpool-Manchester line will be thirty-four and one-half miles of double track, and the rate of progress is put at 110 miles per hour. The cost of working is put at sevenpence halfpenny per train-mile.

A. W.

London, June 27.

THE TELEPHONE AND THE TECHNICAL SCHOOL.[1]

BY J. C. KELSEY.

In this commercial age, whenever a new branch of science or industry exhibits unusual activity and growing importance, the authorities of our universities are ordinarily prompt in adopting a course of instruction especially adapted to that particular work. Electrical engineering, journalism, insurance and commerce are some of the branches which, in these later days, have received consideration by leading universities. A late and prominent branch of industry is that embraced by telephony, and this lusty offspring of electrical engineering now vigorously demands recognition. But progress will be slow in this direction, if we rely upon scholastic opinion. For prior to the adoption of the course of telephone engineering at Purdue University, enquiries were made of many persons known to be interested in the telephone and of a number of professors of electrical engineering. Nearly every person interrogated, who was interested in the telephone from a manufacturing or operating standpoint, was in favor of the movement, while nearly to a unit the idea was opposed by the college people on the ground that there was no call for such a course.

There is a great deal of justification for the attitude of the teachers. For years they have tried to look into the possibilities of the telephone. There was not much to look into, for the pains taken by the telephone interests of past years to help them were microscopic. In most university laboratories, even to this day, a Blake set and an obsolete drop are the sole representatives of a great branch of electrical engineering. Surely, in these there is not much to attract the teacher or the student, much less induce him to look with favor upon the advantages of studying telephony as a life work.

But changes have taken place. Competition brings out man's best effort. The old and experienced telephone man, with his knowledge of detail, has combined his talents with the later generation of electrical engineers, and as a result a system of engineering has been evolved, which combines all the lighter, as well as much of the heavier, construction features of electrical engineering, making the practice of telephone engineering an acceptable profession. However, to place telephone engineering where it rightly belongs one thing yet remains, and that is, the attention of the scientific world must be attracted by our deeds and words. The American Institute of Electrical Engineers is the body to which we look for the official expression of the electrical profession. Everything good, novel and interesting is brought before this body in the fulness of time. It is discussed freely and honestly, and if found meritorious is given a place in the records for all men to read and to think about. If all the telephone engineers had permission (?) or had the inclination to take broad and comprehensive papers before that body, there is plenty of material, the engineering world would more fully realize the breadth of telephony, and scientific men would take more interest in studying the various and vexatious problems now confronting the practice of telephone engineering. But all that has been thus far brought before the Institute is in general a sort of apology, an evasion of the subject by a prolonged discussion of rates, or an assurance that telephone engineering is a broad profession. It will take more than assurances to establish this fact. How much better it would be if an institute of telephone engineers could be organized and perpetuated on a broad basis.

The general public has not been fully educated as regards the telephone. It has seen demonstrations of light and power and transportation, and has been impressed. But the telephone is not a spectacular agency, and the public is not at all impressed. When students enter college to take mechanical or electrical engineering they think they have a definite idea of what they want, and ask no questions. But regarding the teaching of telephone engineering many, many questions are asked: What do you teach? Of what value is it? Is it necessary? Why can not one learn in practical work? What is there about a telephone that takes two whole years of study? Why, my son could talk from the barn to the house years ago.

And a more intelligent lot of questions are asked, such as: Is it of benefit to the telephone field? Are you training young men for the benefit of manufacturers? Are you trying to make them conversant with the operating sides? Is the work of a practical nature? If we hire your graduates, will they be able to take an active hand in our business? And last, but not least, are you Bell or Independent?

These questions can not be evaded, and will be answered here. There seems to be no neutral ground, and a school naturally has to seek neutral ground, not being so constituted as to recognize business complications. Must the telehpone be an exception? The university works in the open field, and its investigations belong to the world. The apparatus it uses must necessarily come from the open field. Freely it gives, and freely is should receive.

To say what should be taught would be impertinent. We want to know that, for we want to make the course for you, to meet your needs. As now planned and administered, the telephone work begins in the junior year, after the student is grounded in mathematics and the fundamental principles of electricity. The students then take up the regular electrical course, simply substituting telephony for the mechanical engineering subjects in the regular electrical course. The first consideration is a study of circuits, beginning with the old series grounded system, on through the metallic self-restoring drop period, and then into common battery systems. Each and every commercial common battery system is discussed and analyzed in the classroom, and in the laboratory the various relays, impedances and lamps are arranged on tables, not only to show accuracy of connection and transmission, but to enable the student to observe the methods and rules of operation.

After the "A" circuits are well understood, the "B" circuit of each system, with the accompanying order wire device, busy test method and manual and automatic ringing, is taken up. The laboratory is divided, so that the "A" and "B" operators are in separate rooms, thereby making the student appreciate fully the usage of the order wire, the method of disconnection, and the general rule of operation.

After the "B" circuit, with its free interoffice service and its charge for interurban service, is investigated, the toll business is studied. The many phases of operation, the methods of switching and recording, and the auxiliary uses of the toll line are given as much attention as is possible outside of regular business.

Upon this foundation, the second year begins the details of the various systems, and a study of the appliances and circuits connected with the chief operator's, chief inspector's, supervisor's, and manager's desks. Complete specifications and drawings of entire systems are made, also a mathematical investigation of the loaded line is made in association with experimental conditions made as practical

[1] A paper read before the convention of the Independent Telephone Association of the United States, Chicago, June 24 and 25.

as possible, operating cable being used for that purpose. The limitations of common battery systems, as regards distance of a subscriber from the exchange, affecting transmission and operation of relays; the effects of induction, from one, two or three-phase alternating currents, from 104 to 9,000 volts pressure, or from continuous currents of from 110 to 500 volts, or from series arc systems; quick and efficient methods of cable testing, finding wet spots, open places and crosses under actual working conditions; considerations of patent law; specifications and estimates upon overhead and underground construction; these are among the features of the course.

Is such a course valuable? In the first place, it must be understood that a technical school does not pretend to teach a man a trade or a profession. It only teaches him how to begin; it prepares him as a skilled apprentice, and not as a journeyman. Failure on the part of the student to realize this has frequently put him in a somewhat disagreeable light.

As to the necessity of the course, the experience of electrical engineering may be recalled. Time has disproved the early claims of the futility of such a course, for all the graduates of the electrotechnical schools are hired by the electrical interests before they leave the institutions. So, upon this evolutionary telephone ground, we hope for the ultimate appreciation of the necessity of telephony having its proper place in the technical schools.

These schools can be of benefit to the telephone field by giving the results of research to the telephone public. And if the schools are given knowledge of the various conditions of service, they will help to evolve, if not a standardization, at least a more general understanding of the rules and laws of design and operation. Schools have time in which to collect facts together and look into details and reasons, which the busy commercial man has not. And if a school can do this, it is certainly an important factor in the progress of telephony, and should be approved of and encouraged by every worker in the telephone industry. The authorities of Purdue are fully convinced that it can do all that has been claimed, and are well satisfied with the results of one year's experience with the telephone.

We feel certain of the approval of every one interested in telephony, and of the cooperation of every branch of the telephone industry in our attempt to build up a telephone course and a telephone laboratory that will be a real benefit to the industry and tend to dignify and amplify telephone engineering as a profession.

A New Building for the New York Times.

The spirit of enterprise which is so definite a part of American newspaper practice, is well evidenced in the far-reaching plans which the management of the *New York Times* has formulated in the choice of a site for, and the structural design of, its new building.

On August 4 last it was announced that the *Times* had secured the triangle bounded by Broadway, Seventh avenue, Forty-second and Forty-third streets, New York city, for the purpose of erecting a building, primarily for its own use. The peculiar geographical formation of New York city, and the localizing of almost all of the large metropolitan dailies in the lower part of the town, made it necessary to stick to this quarter of the city for the manufacturing operation of a newspaper plant, to avoid great inconvenience and loss of time. This was in order that the best facilities for the rapid distribution of editions of the paper might be made use of. With the completion of the underground rapid transit system, this condition will be entirely changed. The trains of that railway will run through the basement of the *Times'* new building. Turning on a curve from Forty-second street up Broadway, the tunnel traverses the lot acquired by the *Times,* and will enter the building obliquely about the middle of the Broadway front, passing out at the Forty-third street end. A terminal station of the subway road will also be erected at this point, giving access to trains without leaving the building. It will be possible, therefore, at the early morning hours when the newspapers are printed, to put the printed copies of the paper on board cars standing within a few feet of the presses, for distribution to various parts of the city.

These conditions have been greatly reenforced by the project of the Pennsylvania Railroad for a great terminal on the Manhattan side of the Hudson River; by the project of the New York Central system for greatly enlarging the area and increasing the use of its terminal at the Grand Central Station and by the projects of the Interborough company for connections across the East River.

The fact that the rapid transit subway will go beneath the structure brings with it, however, some grave architectural difficulties. In order to properly accommodate the presses and storerooms of the newspaper printing plant it will be necessary to excavate and occupy a level which will allow of the subway system and the structural supports which are necessary to uphold the trackage. The floor of the *Times'* pressrooms will be fifty feet below the street level, the actual depth being divided into three stories. Ventilation for this lowest part of the building is provided by an inlet of fresh air through a shaft opened for the purpose, while the exhaust for foul air encloses the main chimney, which extends to bed-rock and the top of the tower. Mr. Cyrus L. W. Eidlitz, of New York city, is architect for the *Times'* building, and the work is to be executed by the George A. Fuller Construction Company. The building will be 375 feet high. It is expected to have the lower stories of the building, from the first to the twelfth, inclusive, and including also the basement, ready for occupancy early in April, 1904.

After considerable discussion, it has been decided to adopt water as the motive power in running the electrical transmission plant which the Dunedin Tramways Company, of New Zealand, is about to erect. In order, however, that the operation of the tramways may not be delayed pending the completion of the transmission plant, a temporary steam plant will be put in. The transmission scheme includes the erection of a powerhouse situated on the banks of the river, about twenty miles from the city, where three-phase current will be generated by turbine-driven alternators and transformed up to 15,000 volts for transmission. From a point near the city, the main transmission line will be divided and branch off to the various substations which will be equipped with Westinghouse rotary converters, with storage batteries, and all necessary appliances. The designs for the whole scheme were carried out by Noyes Brothers, of Sidney, Australia, and the work of construction will also be under their control. All motors and other electrical machinery will be supplied by the British Westinghouse Electric and Manufacturing Company, Limited, the cars being furnished by the J. G. Brill Company.

"*The Four-Track News.*"

The Four-Track News for July is more than ordinarily interesting. This paper is growing, not only in size, but in popular fancy, and at this day it can hardly be called a venture, as it has become a well-established fact. The sketches and stories are just the kind that the busy man or the restless woman is pleased to take hold of and read.

Velocity of Objects Floating in Water.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

I have read with considerable interest the editorial in your issue of June 20, on the velocity of objects floating in running water. I can not, however, entirely agree with either you or General Bentham, nor do I believe the explanation offered by the *American Machinist* to be conclusive.

Your *reductio ad absurdum* fails at the critical point, that is, at the moment when your supposed floating block of ice melts into water and no longer possesses rigidity or tensile strength. General Bentham's explanation is not exact, as will appear later.

Starting with the river-bed, which for the sake of simplicity we will treat as a rough, but uniformly inclined, plane, water, or anything that is placed upon it, will move downward with increasing velocity until the frictional resistance to motion is equal to the component of the earth's attraction parallel with the surface of the plane. If this first body of water be treated as a continually running sheet, and a second sheet of water be superposed on the first sheet, the second sheet will reach a final velocity higher than that of the first, because it is sliding upon a surface itself in motion and offering less frictional resistance.

This argument may be continued until we have any supposable depth of water.

If now an object be placed upon the stream, we might suppose it to act like a superposed sheet of water. However, if it projects into the water to any depth, as a solid floating object would do, the upper parts will be in contact with water moving with greater velocity than the water below. The deeper water will naturally retard its tendency to float as fast as, or faster than, the water near the surface and it will have an intermediate velocity.

It might be possible for a very thin floating object, as a board for instance, to float as fast or nearly as fast as the surface water, and considerably faster than the water at a depth. On the other hand, since the water at a depth would move more slowly than the surface water, it would retard deep floating bodies, and bodies of different shapes would have slightly different velocities.

It is well known to hydraulic engineers that the velocity of water in a stream increases with the distance from the bed and the banks. It is impossible to conceive how a floating body, since it must have depth, could float faster than the very surface of the water, which is in no way tied to the water below it. In your assumed cube of water surrounded by a weightless membrane this condition, of course, does not hold, which destroys the force of your argument. General Bentham's explanation is not correct, since he neglects the retarding action of the water about the lower part of the floating object, although in any case it would have no tendency to move faster than the very surface, unless, indeed, its "skin resistance" were less than that of an equivalent body of water, which is highly improbable.

In the above, the action of the air upon the motion of either the water or the floating object is neglected. Assuming it to be at rest, it would retard the motion of either, and of the floating object more, probably, than of the water.

GEO. H. GIBSON.

Boston, Mass., June 25.

Ventilating Equipment for a Turkish Cruiser.

Messrs. William Cramp & Sons, of Philadelphia, are now building for the Ottoman Empire a large cruiser, to be named the Medjidia. One feature which has been looked after with particular care is the ventilation, which is of great importance in a vessel serving in tropical or subtropical waters. Nine electrically driven centrifugal fans are provided to ventilate the hull of the Medjidia. Fan No. 1 is a forty-inch steel-plate "exhauster," which will supply air above the protected deck, forward, while No. 2, of the same size, will supply air below the protected deck forward. Fan No. 3 is an exact duplicate of No. 1 and will supply air between frames 65 and 66 aft. No. 4, of the same size, will furnish air aft of frame 66. No. 5, which is a fifty-inch steel-plate "exhauster," will supply air to the dynamo and evaporating rooms. No. 6, a "Monogram exhauster" having a cast-iron housing, will supply air to the crew's quarters between frames 10 and 24. This fan is bolted to the ceiling and is driven by an electric motor supported on the side of the fan. Fan No. 7, which furnishes air to the crew's quarters between frames 24 and 34, is similar to fan No. 2. Fan No. 8, for the crew's quarters between frames 34 and 35, is a duplicate of fan No. 6, and No. 9, of the same size and character, furnishes air to the officers' quarters between frames 55 and 83. The forty-inch fans are capable of supplying 4,260 cubic feet of air at one ounce pressure when running at 822 revolutions per minute and one and one-half ounces when running at 1,010 revolutions. The fifty-inch fan will supply 3,690 cubic feet at one ounce pressure at 660 revolutions, and one and one-half ounces at 808 revolutions. The four "Monogram" fans can supply 2,110 cubic feet of air at one ounce pressure running at 822 revolutions per minute or at one and one-half ounces when running at 1,030 revolutions per minute. The entire ventilating equipment above described was furnished by the B. F. Sturtevant Company, of Boston.

BOOK REVIEWS.

"A Few Remarks." Simeon Ford. New York. Doubleday, Page & Company, publishers. Price $1.00.

This book is a life-lengthener. It is full of dry humor and quaint philosophy. A delightful vein of sarcasm prevails in all its chapters, thirty-seven in number, each an address delivered as an after-dinner address. Mr. Ford's "Remarks" are a unique and entertaining addition to humorous literature. In them he treats of the automobile and the electric railway, as viewed by the observer on the street and the passenger on the car. The book will be read and enjoyed by many, and we all hope there will be more from the same sprightly, good-humored pen.

"American Street Railway Investments." Published annually by the *Street Railway Journal*. New York. McGraw Publishing Company. Cloth. 9¾ by 13 inches. 350 pages. 25 maps. Supplied by the ELECTRICAL REVIEW at $5.00.

This is the tenth annual volume, and contains reports of 1,361 companies, showing in detail the physical and financial condition of the properties. Of this number nearly 1,300 reports are of an official character, the information being furnished by the railroad companies themselves. The figures include both operating and leased roads, and also data of all new roads. Figures are given for all important consolidations during the year, and a valuable feature is the arranging of the reports of companies by states instead of alphabetically by towns, as heretofore. The volume contains about twenty-five folding maps, some of these in colors, of the most important street railway systems in the United States. A table is given showing by comparison the gross receipts of all companies earning $25,000 or more for the years 1901 and 1902. The report in each case is followed by the date of the information as supplied by the street railway company making the report. It is surprising to those who have had occasion to answer enquiries of this nature, how much a work of this description is appreciated. This volume does for the street railway interests what is absolutely essential for all the other branches of electrical industries. The information is given in a way that can be easily comprehended, the indexing is very complete, and the maps are of great advantage in determining geographical as well as physical conditions. The book is, and ought to be, very popular.

The National Electrical Contractors' Association Third Annual Convention, Detroit, Mich., July 15, 16 and 17.

THE third annual convention of the National Electrical Contractors' Association of the United States will be held at Detroit, Mich., July 15, 16 and 17. In connection with this exhibits will be made by electrical manufacturers at the Light Guard Armory. A New York Central & Hudson River Railroad special from New York to Detroit will leave New York, Grand Central Station, on Monday evening, July 13, at eight o'clock. Going, tickets will permit stop-over at Buffalo for delegates who may wish to attend the meeting of the United Electrical Contractors' Association of New York State on Tuesday, July 14. The New York state members will go up to Buffalo on July 14, and gathering forces at this point will leave Buffalo over the Michigan Central line at 6.25 P. M., July 14, arriving in Detroit at 12.25 A. M., July 15; or they may go by way of steamer, leaving Buffalo at 5.30 P. M., July 14, arriving in Detroit at 7.30 A. M., July 15.

The National Electrical Contractors' Association of the United States was organized in Buffalo, July 17, 1901, at a meeting called for this purpose by the United Electrical Contractors' Association of New York State.

The electrical contractors have for a long time been a factor in the building business of the country, and as the trade increased in magnitude the necessity of organization became apparent. The association movement was first started by the formation of local associations in the different cities in New York State. In August, 1899, these local associations met and formed the United Electrical Contractors' Association of New York State. This organization proved to be such a benefit to the members, that in 1901 it was decided to issue a call for a meeting of electrical contractors from all parts of the country, to be held in Buffalo in July of that year.

This meeting was largely attended and enthusiastic inauguration of the National Association participated in. Since that time, the organization has grown steadily, and at the present moment has a membership list including contractors from all parts of the country and thoroughly representing the electrical contracting business. In connection with the association, a monthly paper called *The National Electrical Contractor* is issued. This paper is not in any way a technical journal, but is devoted to the interests of the electrical contractor.

The object of the association is to formulate plans for the equitable carrying out of business in every quarter of the country. Much good can be accomplished by the getting together of the men who represent large expenditures of capital and the manipulation of large numbers of laboring men. The accompanying photographs and sketches will give a fair idea of the characteristics of the gentlemen who make up the personnel of this organization.

CHARLES L. EIDLITZ.
President National Electrical Contractors' Association.

Mr. Charles L. Eidlitz, National president, is the son of Marc Eidlitz, who was the founder and first president of the Building Trades' Association. Mr. Eidlitz is thirty-six years old and was born in New York city. He graduated at Columbia University in the class of 1888, and was a member of the famous boat crew of 1885. He has been engaged in electrical engineering and contracting in New York city for the past fourteen years, and several hundred of the more prominent buildings in New York city are equipped with apparatus and material installed by his company. A notable installation which was made by Mr. Eidlitz is the new headquarters of the New York Stock Exchange, which was elaborately described a short time ago in these columns. While Mr. Eidlitz is a phenomenally busy man, he is at all times approachable and has the reputation among his business associates and those who are working for him of being the fairest minded employer in the city. His personality is one which convinces the observer of great forcefulness and at the same time an expression of cordial good will is always evident in his bearing. Mr. Eidlitz is a member of the Electrical Contractors' Association of New York city, the Electrical Contractors' Association of New York State, and is now president of the Building Trades Employers' Association. As the organization of the National Electrical Contractors' Association was largely due to the work of Mr. Eidlitz, he, in conjunction with Mr. E. S. Keefer, issuing the first call for the national body, so he is the leading spirit in the Building Trades Employers' Association. Credit is entirely due to Mr. Eidlitz for the formation of this organization. It was following his speech before a large gathering of building trades employers in New York city that the Building Trades Employers' Association was launched, and he was immediately elected first president. He is a member of the New York Electrical Society; president of the Charles L. Eidlitz Company, electrical engineers and contractors; treasurer of the Metropolitan Switchboard Company, and he is also interested in the Goetz Manufacturing Company. In 1889, Mr. Eidlitz was married to Miss Margretta Ruth Lydon, daughter of one of the prominent contractors of New York city in the earlier days. They have one child, a daughter, thirteen years of age.

Mr. G. M. Jones, of Minneapolis, Minn., is the first vice-president of the association.

Mr. E. T. Cooke, of St. Louis, Mo., second vice-president, is one of the pioneers among the electrical contractors, starting wiring and bell-hanging as far back as 1867.

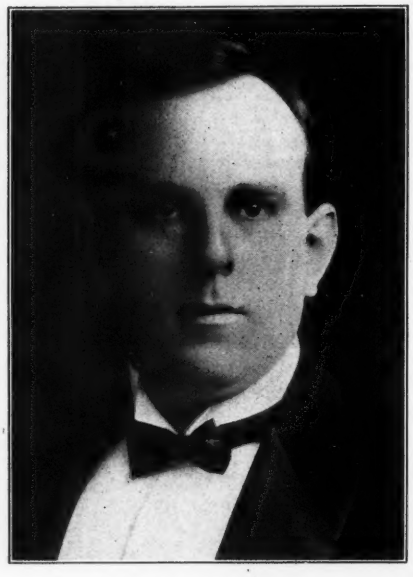
Mr. H. K. McCay, of Baltimore, Md., third vice-president of the association, is a graduate of the United States Naval Academy of the class of 1884. He resigned immediately from the navy and took up special technical training under Professor Helmholtz, in Berlin, Germany, continuing this work for nearly

two years. Upon returning to the United States, he immediately joined forces with the Marr Construction Company and assisted in installing many of the present Edison illuminating companies, including the Wilkesbarre, Scranton, New Orleans, Birmingham and many other similar installations. After installing the Birmingham station, he took charge of this station for three years, until it was bought up by a competing company and consolidated therewith. Following this venture, he assumed charge of the Lighting and Street Railway Company, of Amsterdam, N. Y., and operated this company, constructing a large portion of the extensions to track and overhead work of the company.

E. T. Cooke.
Second Vice-President.

In 1890, he founded the McCay-Power Engineering Company, which was later absorbed by the McCay Engineering Company. This company has developed into one of the largest constructing companies in the South, installing principally lighting and power plants throughout this territory. One of the largest pieces of engineering was the laying of three submarine cables for the United States Weather Bureau. These cables were successfully laid from Key West, a distance of ten miles, to Sand Key; from the South Farallone Islands, Cal., a distance of twenty-five miles, to Point Reyes; and from Glen Haven, Mich., a distance of eight miles, to South Manitou Island. Mr. McCay personally managed the work of installing all three cables, and has received many congratulations on the successful consummation of this engineering project. The Farallone cable is remarkable, owing to the fact that it is the longest gutta-percha cable ever manufactured and laid in this country.

Mr. George R. Mathieu, of Pittsburg, Pa., treasurer of the association, has served in this capacity since the inauguration of the body. In addition to this, he has been president of the Association of Electrical Contractors in Pittsburg and western Pennsylvania for four years, and when in last July a number of its members dropped out and formed a new body known as the Pittsburg Electrical Contractors' Exchange, he was made president, and also formed the Electrical Contractors' Association of the State of Pennsylvania in 1902, of which association he was made president, and has served that office ever since. Mr. Mathieu has been in the electrical business in Pittsburg for fourteen years, and in that time he has wired some of the largest and finest residences and business houses there. He has also installed the electric work in several of the modern skyscrapers in Pittsburg. Mr. Mathieu is a public spirited man, and is connected with several of the public institutions, and is secretary of the board of directors of the East End Hospital.



George R. Mathieu.
Treasurer.

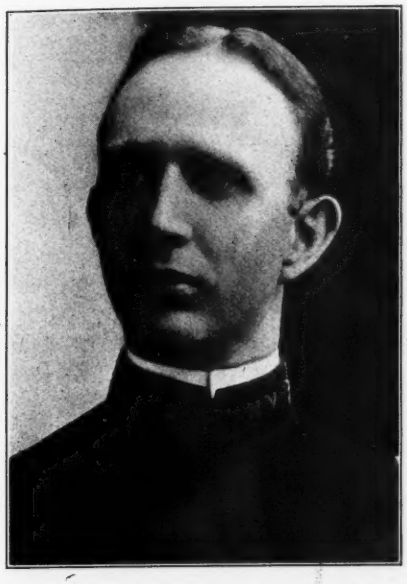
Mr. Walter H. Morton, of Utica, N. Y., secretary of the association, is a popular figure in this field. He was born in Springfield, Mass., and is the son of Judge James H. Morton and grandson of Governor Marcus Morton. He was educated in the public schools of Springfield, Mass., and afterward took a three years' course at the Gunnery School, Washington, Ct. In 1889, he went to Schenectady, N. Y., and took a student's course in the General Electric Company's works. After completing this course, he had charge of the testing department of the Schenectady works until 1885, when he went to Utica, N. Y., and engaged in the electrical contractors' business with the firm of Nightingale & Johnson, of which he was soon made a partner. In 1897, the firm became Johnson & Morton, and since that time it has done a large contracting and manufacturing business. Mr. Morton was four years secretary of the United Electrical Contractors' Association of New York State, and is still a director in that organization. He has been secretary of the National Association since its formation, and is manager of the *National Electrical Contractor,* a monthly paper devoted to the interest of the electrical contracting trade.

Mr. J. C. Sterns, of Buffalo, N. Y., sergeant-at-arms of the association, is the senior partner of J. C. Sterns & Company, of Buffalo, N. Y., his partner in business being Mr. Walter Cary. Mr. Sterns was born in 1860, and has been interested in electrical engineering for some twenty-five years. In the year 1890, he entered into copartnership with Mr. F. P. Jones and carried on business under the name of F. P. Jones & Company. In February, 1897, Mr. Sterns dissolved partnership with Mr. Jones, Mr. Sterns and Mr. Cary carrying on the business since that time. The principal specialty of this firm is electric light and power equipment, special attention being given to Niagara Falls power installations. Mr. Sterns has been active in the organization of the Electrical Contractors' Association since its first inception in Buffalo in 1892, when the first Electrical Contractors' Association in the country was formed. Mr. Sterns is at present a di-

W. H. Morton.
Secretary.

rector in the New York State Contractors' Association, being treasurer of this body.

Mr. Edmond D. McCarthy, of Buffalo,



E. D. McCarthy.
Director from the State of New York.

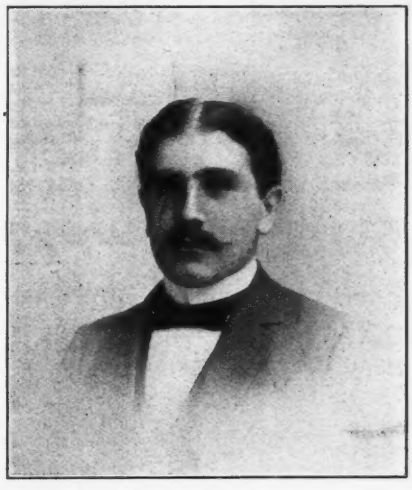
N. Y., is one of the directors from the state of New York. He is president of the Buffalo Electrical Contractors' Association. Mr. McCarthy started in the electrical contracting business with Little, McDonald & Company, of Buffalo, in 1890, remaining with this company and its successors until March 1, 1898, having filled the positions of superintendent, assistant superintendent and general

James Hilton.
Director from the State of New York.

manager, when he resigned and entered the field of electrical work on his own account with Mr. Eugene J. McCarthy and Mr. Henry R. Ford, under the firm name of McCarthy Brothers & Ford, doing a general electrical manufacturing, engineering and supply business.

Mr. James Hilton, one of the directors from the state of New York, started in the electrical business with the Thomson & Houston Electric Company at Lynn, Mass., in 1887. In 1890, he left this connection to take charge of the electrical repair department of the Electrical Engineering and Supply Company, of Syracuse, N. Y. In March, 1894, with Mr. F. S. Rogers, he formed the firm of Rogers & Hilton. He is president of the Syracuse Local Association of Electrical Contractors and a director of the State Association ever since it was formed.

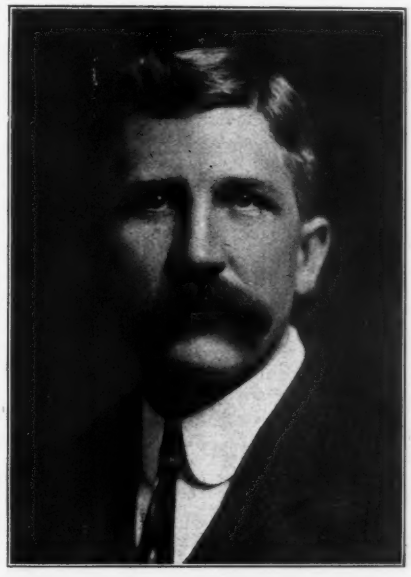
Mr. Howard A. Loeb, of Philadelphia, Pa., is the director for the state of Pennsylvania. Mr. Loeb was born in Philadelphia, April 25, 1873, graduating from the University of Pennsylvania with the



H. A. Loeb.
Director from the State of Pennsylvania.

degree of Bachelor of Science in 1893. In 1894, this university gave him the degree of Mechanical Engineer. Since that time he has been a member of the firm of Messrs. Francis Brothers & Jellett, Inc., mechanical and electrical engineers and contractors, with offices at No. 245 North Broad street, Philadelphia, and 47 East Eighteenth street, New York city.

Mr. E. McCleary, of Detroit, Mich., is the director for the state of Michigan. Mr. McCleary is a member of the firm of McCleary & Colquitt Company, Ltd., electrical contractors and dealers, Detroit, Mich. Mr. McCleary is one of the most popular men in the national organization. He not only possesses a thorough training as an electrical engineer, but has a knowledge of the law which has been of inestimable value in all sessions of the directors of the association. He has been actively interested in the national body since its organization, and was early recognized as a leader in the organization. His selection by the nominating committee as next president of the National

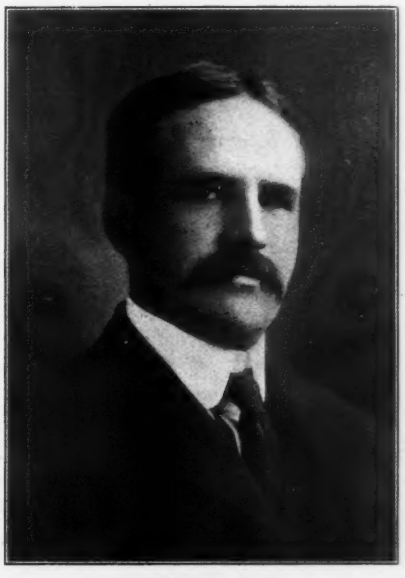


E. McCleary.
Director from the State of Michigan.

Association is in recognition of his great fitness for this position of trust. He is a man of pleasing personality, and his friendship is greatly valued.

Mr. W. I. Gray, of Minneapolis, Minn., is the director for the state of Minnesota. Mr. Gray is a member of the firm of W. I. Gray & Co., engineers and contractors, Minneapolis, Minn.

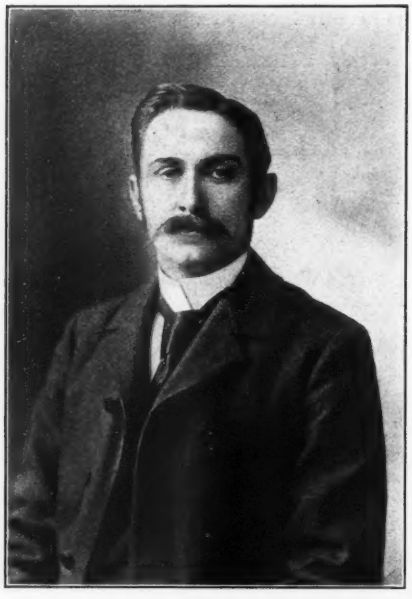
Mr. John K. How, of Baltimore, Md.,



W. I. Gray.
Director from the State of Minnesota.

is the director for the state of Maryland. Mr. How started in the electrical business in 1882 as an employé of the Edison company for isolated lighting in New

York city, and was with this company until 1886, when he started as an electrical contractor in Baltimore, Md. He has been engaged in this business since that time in this city. Mr. How was one



JOHN K. HOW.
Director from the State of Maryland.

of the organizers of the Electrical Contractors' Association of the State of Maryland, and has taken an active part in its affairs ever since. When the National Electrical Contractors' Association was formed two years ago, he was chosen a director, which position he has held since that time.

F. E. NEWBERY.
Director from the State of Missouri.

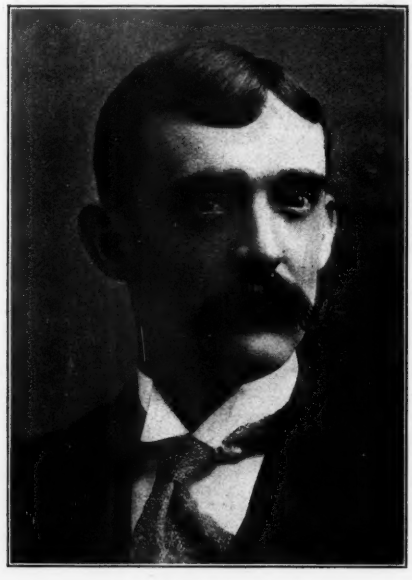
Mr. F. E. Newbery, of St. Louis, Mo., is the director for the state of Missouri. Mr. Newbery is a graduate of the Finsbury Technical College, London, England, and has been engaged in the electrical engineering and contracting business in the United States for the past fifteen years. He has been located in St. Louis, Mo., and has built up a very successful business under the firm name of F. E. Newbery & Company, installing a line of heavy work covering the field of California in the West, Georgia in the Southeast and Texas and New Mexico in the South. The advent of the Louisiana Purchase Exposition has materially increased this firm's business this year, as it has been awarded the permanent work in connection therewith.

Mr. G. N. Sanborn, of Indianapolis, Ind., is the director for the state of Indiana. Mr. Sanborn has been engaged in the electrical contracting business in Indianapolis for the past twelve years.

G. M. SANBORN.
Director from the State of Indiana.

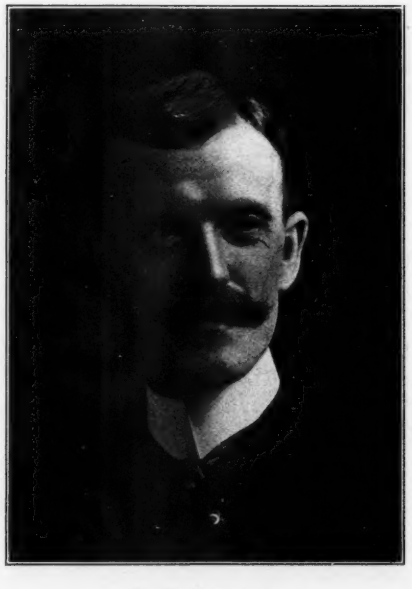
He organized the Sanborn Electric Company, which two years ago consolidated with the Advance Electric Company, incorporating under the firm name of the Sanborn-Marsh Electric Company. Mr. Sanborn is president of this firm. He has taken an active interest in the National Electrical Contractors' Association since its organization, having served on the board of directors and as chairman of the Underwriters' Committee which met with the Underwriters' Electrical Committee in December, in New York. It was under his leadership that this committee was successful in bringing to the attention of the underwriters the importance of cooperation with the contractors. This matter of methods of inspections and underwriters' rules is a specialty with Mr. Sanborn, and his services have been of great value to the electrical industry at large.

Mr. David Marsden Anderson, of Washington, D. C., is the director for Washington, D. C. Mr. Anderson is thirty-seven years old and was born in Fayetteville, N. C., and is a direct descendent of James Matthews, who was a



D. M. ANDERSON.
Director from Washington, D. C.

General of the Revolutionary War and prominent in the early history of the state of Virginia. Mr. Anderson, like many other boys of the South at that time, was by the fate of war denied the advantages of a college education. He preferred the mechanical training, and at an early age entered a railroad loco-



E. M. LAWTON.
Director from the State of Ohio.

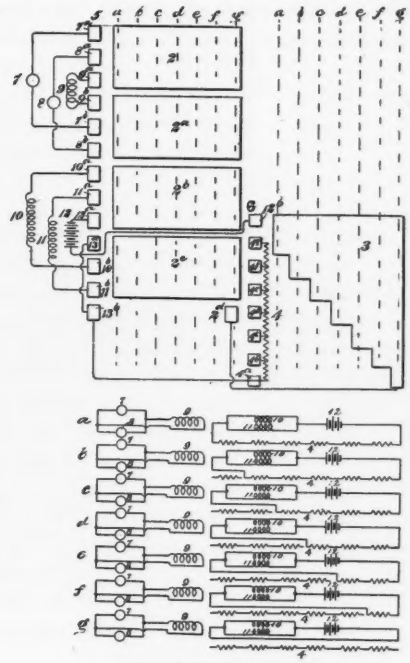
motive shop where he learned the first principles of what was to be his life work. His ambition carried him to Richmond, Va., and when the old Sprague company came there to build the electric street

railway he secured a position with it, and by his great application to the business soon rose to positions of importance. The company sent him from Richmond to Ohio as assistant in charge of the construction of a railway to be built there, and later he was sent to other places as superintendent of construction in full charge of all its work. At this time, he was but twenty-two years of age. He was also superintendent of construction of the old Edison General Company at its southern office, and has been identified with the installation of electric railways and lighting plants in the states of New York and Pennsylvania, and throughout the South, as well as in Central and South America. For the past four years Mr. Anderson has been in the electrical contracting business in Washington, D. C., and has taken an active interest in the Electrical Contractors' Association, being among the first to start activity in this line. He was the first from this district to represent the electrical contractors on the National Board of Directors. Mr. Anderson is now the head of the firm of D. M. Anderson, Mariner, Son & Company.

Mr. Ezra Mills Lawton, the director for the state of Ohio, is a native of that state and was born in Ironton in August of 1864. Mr. Lawton is not a college man, but a graduate of public schools, and for some years looked upon the medical profession as his future work. While employed as civil engineer with one of the leading railroad systems, a romantic meeting with his future wife convinced him of the futility of his ambition toward his career as a physician, and it was an easy step from civil engineer to electrical work. For a number of years Mr. Lawton was superintendent of construction of the combined Cincinnati Lighting Companies. He has filled many electrical positions, his first work dating back some seventeen years. He has had great success in telephone engineering, working as operator, lineman and superintendent of exchanges, and has filled places in lighting and power installations from the most humble position to the head of a department. For the past eight years, Mr. Lawton has been actively engaged in contracting, and as president of the Lawton Electric Company is doing a prosperous business in Cincinnati, Ohio.

Electrical Patents.

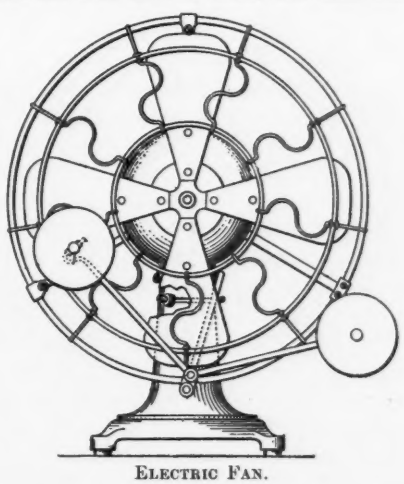
The Westinghouse Electric and Manufacturing Company has obtained control of a patent issued to Mr. Ernest R. Hill, of Wilkinsburg, Pa., on a new electric brake. The invention relates to means for braking electrically propelled vehicles, and particularly to such means as utilize the propelling motors to generate current for energizing the magnets of brake-shoes when the current supplied to the motors is cut off and their armatures are propelled by the momentum of the vehicle acquired during the time when the machines were operating as motors or by the momentum due to the grade of the track. In the operation of electric or electromagnetic brakes, as heretofore generally practised, the field magnet and armature windings of the motors are connected in a closed circuit with a considerable amount of external resistance when the main line current is cut off, so that the motors then act as series-wound generators to supply



ELECTRIC BRAKE.

energy to the brake magnets. In the use of the motors in this manner, since all of the current generated must pass through the field-magnet windings, these windings become heated to a high temperature. The magnetic density of the armature cores is also raised to a high point by reason of the large current in the field-magnet coils, and the resulting iron losses cause a high armature temperature. Furthermore, the large amount of external resistance necessarily included in the circuit at the beginning of the braking operation is such that the brakes do not act as quickly as is sometimes desired, since the energizing current for the brake magnets is cut down to a very small amount by such resistance. In order to obviate these objectionable features, Mr. Hill proposes to connect the field magnets and armatures of the motors in separate circuits for braking purposes and to energize the field magnets by current from a separate source of current, preferably a battery of the secondary type. With this proposed arrangement there need be, and preferably will be, no external resistance in the armature circuits, the variable resistance or other means for varying the field magnet excitation, and consequently the braking effect, being all included in the field magnet circuits. A further feature incident to the invention resides in the fact that an independent source of current for the field magnets ensures a certain amount of braking action under conditions that would preclude such action if the energizing current were derived from the armatures.

Another improvement in oscillatory buzz fans has been invented and patented by Mr. Charles A. Eck, of Belleville, N. J. A suitable base is employed having a standard provided with a vertical socket in which is journaled by means of ball bearings a vertical spindle. This spindle carries at its upper end the usual motor and fan, the latter being surrounded by an ordinary wire guard. Secured to the bottom of this guard is a fixed sleeve in which is journaled a rock shaft. The outer end of the rock shaft carries a pair of divergent arms having hook-shaped terminals. Upon these terminals are adjustably mounted vanes which are adapted to swing into and out of the current of air from the fan and on opposite sides of the centre of the same when the rock shaft is swung. The inner end of the rock shaft is provided with an upstanding finger located between the rear of the fan and the standard of the base. Upon this standard are adjustably attached two outstanding stops located in the path of movement of the finger. The vanes are so arranged that when one is in the path of the current of air produced by the fan, the other is out of such path, and consequently the force of the air coming from the fan will tend to move the vane out-



ELECTRIC FAN.

wardly. As already stated, this vane is on one side of the centre of the fan, and, as a result, the fan will be swung upon its vertical axis. As soon as the upstanding finger at the inner end of the rock shaft comes into contact with one of the stops of the standard, the rock shaft will be swung, thus bringing the opposite vane into the current of air, while moving the first-mentioned fan out of such current. The movement of the fan is thus reversed. The speed of oscillation can be varied as desired by inclining the vanes to any extent.

Electrical Notes from Europe.

From Our Special Correspondent.

THE southern section of the Paris Metropolitan is now in construction and is making rapid progress. This new portion makes a semi-circular turn through the southern districts of the city, on the same general plan as the north section, which has been previously described, and is now practically finished. The two lines will make practically a circle and when completed will form a continuous belt line around the city. The old Metropolitan, which runs east and west and parallel to the Seine, will bisect the circle, and at the two points of junction will be two important stations, one in the eastern and the second part of the city. The western station has already been completed, under the Place de l'Etoile, as from this point a short section of the new southern line was constructed as far as the Seine shortly after the old Metropolitan, and now terminates at the underground station of the Trocadero. The new line which is now in construction starts from this point and runs underground for a short distance. It then comes out near the river bank and will cross the Seine on a specially designed bridge not far from the Eiffel Tower. After leaving the bridge the line continues upon an overhead structure which is erected in the middle of the principal boulevards and is supported upon iron columns. After passing over the low-lying districts near the Seine it then runs in an underground section which continues for some distance, and then comes out upon a second overhead portion which is about half as long as the first, which was needed owing to a depression in the ground at this point. The length of the viaduct over the Seine valley is 8,278 feet, while the second overhead part is 2,818 feet long, making the total length of the overhead structure 11,096 feet, which is more than one-third of the entire line which is about five and a half miles long. The trusses have been mounted as low as possible, with a minimum of seventeen feet above the ground, this height being sufficient to allow the double-decked cars to pass. Most of the spans are from sixty-five to eighty feet long, but in a few cases the length of the span reaches 145 feet. There will be fifteen stations over the whole section, which, added to the three which already exist on the Etoile-Trocadero part, make eighteen stations in all over the total length of five and one-half miles. At the terminus of the section at the Place d'Italie (from which a branch is to join on to the old Metropolitan) there will be two underground stations side by side. One of these belongs to the present line and the other is the main terminus of a new line which is to be constructed later. The passengers can pass from one station to the other to change cars. The station of the present line will be of the usual type, with a platform thirteen feet wide on each side of the track. Of the fifteen stations on the southern line, six will be built overhead on the viaduct part, and here the construction is somewhat widened to form the station platforms, and the outer parts are supported on masonry columns somewhat as in the northern section. The other stations will be nearly at the ground level, as they are placed at the points where the line passes from the overhead part into the tunnel. This is carried out on an easy grade and the cutting which leads to the tunnel will be partly roofed over on a level with the street. The new bridge which will be erected to carry the road over the Seine will be of considerable size. The contract for this work has been lately awarded to Daydé & Pillé, a large construction firm. As there is a small island in the middle of the river, the bridge will be built in two parts. From the underground section trusses of 280 feet total length will lead to the bridge proper, which has a central span of 170 feet with a ninety-eight-foot span at each end, or 376 feet in all. The length of the second part is about 300 feet. The first level of the bridge will be used for ordinary traffic, while the Metropolitan tracks will be carried upon an upper structure supported from the first platform by iron columns.

A new method of measuring the frequency of alternating currents has been devised by M. Pierre Wyss, of Paris. For this purpose he uses a vibrating cord which can be stretched at varying tensions and brought into resonance with the current. The cord is an iron wire which is stretched upon a suitable support. At the middle point of the wire is mounted a small electromagnet carrying the current whose frequency is to be measured. The cord is fixed at one end, while the free end is attached to one arm of a right-angled lever. The second arm of the lever has a spring attached to it and by varying the tension of the spring the wire can be stretched more or less tightly over the board. To a point near the spring is fixed a needle, which is mounted so as to move over a graduated dial as the tension of the spring is increased; the dial is graduated in frequencies. On turning the wire so that it has double the number of vibrations of the alternating current it comes into resonance with the latter and the magnet has a more powerful action upon it, causing a great increase in the amplitude of vibration. This produces a visible effect and the moment at which the cord comes into resonance with the current is easily observed and the point of the dial corresponding to the frequency is noted. This forms a very simple device and it works very well in practice. With one of these instruments which reads from forty to sixty cycles the frequency can be easily determined within one-tenth of a cycle.

An electric railway system of some interest is shortly to be constructed in the south of France, in the Pyrenees region, and as it traverses a mountainous district its construction will present some special features. The road will be built in two lines. The first of these will start from the branch of the southern railway system which leads from the Mediterranean coast as far west as Villefranche, and will run from this point for a distance of thirty miles, ending at the Spanish frontier. The electric road will make a steep climb for the first eighteen miles as the difference of level is 3,900 feet over this distance. The second electric line will start from Axat, which is the terminus of another railroad branch somewhat further north, and will run directly south through the valley of the Aude, joining on to the first line at Mont Louis. This road will be about twenty-five miles long, with a climb of 4,000 feet from Axat to Mont Louis. From the latter point the two lines continue together to the frontier, and it is proposed to make connection from this point with the main railroad line which runs to Barcelona. The new roads will traverse a mountainous district of considerable interest, and will prove of great benefit to the inhabitants of the region as well as to the numerous tourists which frequent this picturesque locality. The character of the country over which the road passes will make it necessary to construct a great number of tunnels and viaducts and the

road will contain many short curves and steep grades. Besides the passenger cars it is proposed to run freight trains which will carry heavy loads of ore as well as granite and marble and other products of the region, also heavy forest timber. To supply power for the road several large hydraulic plants are to be built which will employ different mountain streams of the Pyrenees region. This enterprise is to be one of the most important in southern France.

The municipality of St. Petersburg is shortly to transform the sixty miles of lines which it controls from animal to electric traction. The trolley system is to be used, both on the city and suburban lines. Within the city limits the road-bed is to be constructed of armed beton, using Phenix rails, but in the suburbs wood ties will be used, with Vignole rails. The power for the electric system will be furnished from a large plant which is already used for the lighting system. A substation is to be erected in the Alexander Gardens, where the alternating current supplied from the central station will be transformed to continuous current by a set of rotary converters with their transformers. Later on it is expected to erect a number of other substations. The new system will start with fifty-five cars, divided into first and second-class compartments. These cars, which will contain fifty-two places in all, will have a central platform with one of the compartments at either end.

Electric traction on main railroad lines is now occupying considerable attention in Italy, and some interesting work is to be expected in this direction. The Minister of Public Works is now making plans for running electric trains over the existing tracks between Rome and Naples, as well as for constructing a new road between the two cities especially for electric traction. On the other hand, the Mediterranean Railroad Company is shortly to introduce the electric system on some of its lines. The first step will be to transform the Rome-Albano-Nettuni and four other branches which have a total length of 200 miles. It is estimated that 14,000 horse-power will be needed for this extensive system. The two lines from Rome to Naples will no doubt take 20,000 horse-power, while if electric traction is applied on the Roccasecca-Arenza branch, as proposed, 17,000 horse-power will be needed for the latter. The whole system will thus take no less than 54,000 horse-power, which is to be supplied from a number of hydraulic plants to be constructed for the purpose. The Valtellina electric railroad is now in successful operation and an order has lately been given to the Ganz Company for three new electric locomotives of fifty-five tons each, which will be used either for passenger or freight trains. The locomotives will be mounted on four axles with a motor on each axle, and will be the heaviest which have yet been built in Europe. They are to draw the passenger trains at a speed of forty miles an hour and the freight trains at twenty miles. Another important project in Italy is that which is to be carried out by the Oerlikon Company, which is to erect a large hydraulic station for light and power distribution to Brescia and the different industrial plants in the neighborhood, which are especially engaged in electrochemical work and use a large amount of power. One of the remarkable features of this plant is that the distribution is to be made at 40,000 volts, which is the highest tension that has been yet employed in the country. The Caffaro River, which is a tributary of the Chiesa and has its origin in the Tyrolian Alps, will furnish the power. Two plants are to be erected near each other on this stream, and together they will take about 12,000 horse-power. The first of these plants is now being constructed at Bageline and is to use 7,500 horse-power with a seventy-five-foot head of water. The canal leading the water from the river to the station will be 13,500 feet long, of which three sections or 7,000 feet will be laid in tunnel. The station will contain turbines of 2,000 horse-power which drive three-phase alternators, giving 9,000 volts at forty-two cycles. A series of step-up transformers will raise the tension from 9,000 to 40,000 volts for the line. Venice is also to be supplied with a light and power system from a hydraulic plant which will be erected in the neighborhood. A large company has recently been formed for this purpose and it has already obtained the concession from the municipality. The power of the Cellina River is to be used and a generating station is to be erected at a point near Varci within the next two years.

One of the new Swiss electric plants is that of Vouvrier, which is erected on the bank of the Rhone a few miles from the point where it leaves the Lake of Geneva. The hydraulic power which is thus obtained is 3,000 horse-power, on an average, which is furnished by a head of water of 2,700 feet. The plant takes the water directly from the lake by a natural fissure which affords a flow of sixty gallons per second. The water is brought from there to the station by a canal 1.2 miles long. To the end of the canal is joined a steel penstock 1.7 feet in diameter which is laid underground. The penstock, which is 2,080 feet long, ends in a basin from which lead two branch conduits of smaller diameter; the latter run for 5,850 feet to the station building. The turbines and alternators are installed on the upper floor, leaving the lower for the water system. The station contains two alternators of the Brown-Boveri pattern which are driven by 500-horse-power turbines. The latter have been furnished by the Piedboeuf firm of Düsseldorf. The exciters of these machines are mounted on the same shaft opposite the turbines. Two other alternators of the Thury pattern, which are of the monophase type, giving 6,000 volts at fifty cycles, are driven at 1,000 revolutions per minute by 500-horse-power turbines built at the Vevey works. The Thury alternators are excited by two small direct-current turbine groups of twenty-five horse-power. This plant can be run in parallel with a second station in the same region at Vuargny, which is operated by the same company, and the two plants are used to distribute light and power in the surrounding districts.

C. L. DURAND.

Paris, June 27.

Electric Process of Making Castings.

C. A. Keller, of Paris, has patented in France and England a process for the electric heating and refining of metals and other substances. An auxiliary feed chamber is employed in connection with electric or other smelting furnaces, which takes the form of a tapping ladle mounted on a movable truck. This can be moved close to each furnace of a battery, in order to receive the metal tapped from it. It is then passed under a group or groups of vertical electrodes, which are plunged into the fused material coming from the furnace. This material is thus placed in the electric circuit and maintained at the requisite temperature for mixing and refining in the auxiliary refining chamber, and for subsequent casting into moulds. The electrodes are arranged vertically and in groups comprising two or more positive and negative electrodes, so that one electrode can be easily replaced without the necessity of stopping the operation. Another arrangement consists of a cupola, the front basin of which replaces the ladle, and receives the fused material. Vertical electrodes dip into the material, and maintain it at a temperature required for refining the cast and transforming it directly into steel.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Electricity in Mining.

In both coal and metallic ore mining electric power is being successfully applied to hoisting, hauling, drilling, cutting, ventilating, pumping and lighting. Unequaled ease of control in the operation of machinery, the great flexibility of electric circuits, and the facility with which the mining machinery may be carried into inconvenient places make the use of electricity of great practical advantage. From time to time there have been brought to the attention of engineers the alleged dangers which arise from electric current when used in deep levels in mining, but the great development which has been made in recent years has, without doubt, overcome many, if not all, of these difficulties. There are many instances of operation in present-day mining, where work would have to be abandoned entirely were recourse only to be had to the older forms of mining machinery. With the ability to carry the electric conductor into the deepest recess of the bottommost level, and with the high quality of insulation which is now possible, the electric motor can be made use of in hundreds of practical ways. Not only is the electric motor useful for working the cutting machines, driving the ventilating fans and operating the pumping machinery, but it also has a valuable application in connection with hoisting machinery for haulage and where conditions make it possible for operating locomotives carrying the coal bunkers from the headings to the shaft entrances, or the openings of the pits.

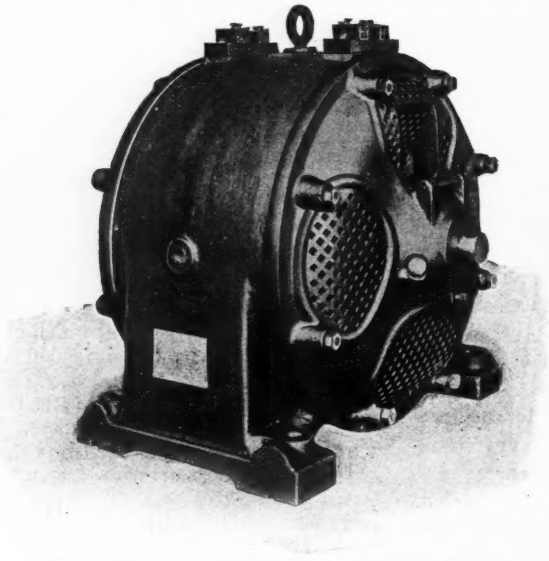


FIG. 1.—TWENTY-HORSE-POWER INDUCTION MOTOR.

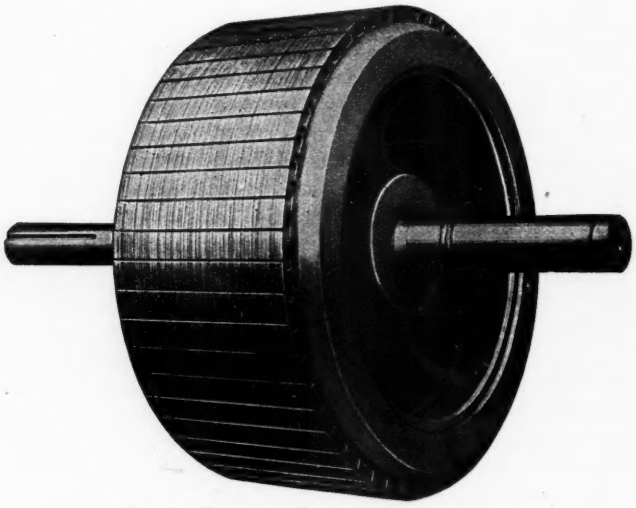


FIG. 2.—ROTATING PART OR SECONDARY OF INDUCTION MOTOR.

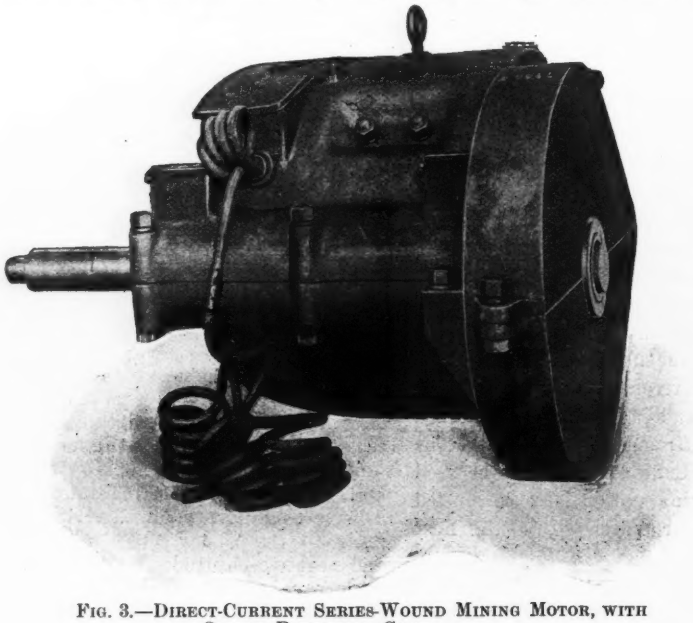


FIG. 3.—DIRECT-CURRENT SERIES-WOUND MINING MOTOR, WITH SINGLE REDUCTION GEAR.

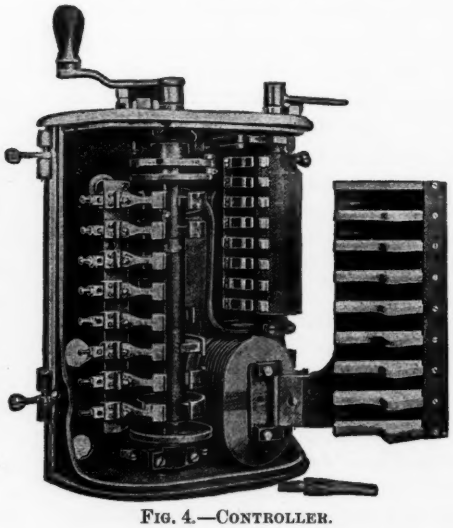


FIG. 4.—CONTROLLER.

The Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., has developed a line of apparatus which is

especially adapted for mining purposes. This apparatus is the result of years of concentration and specializing along the lines most needed for such service. While this line is standardized to a considerable degree, the company makes careful investigation of the conditions to be satisfied, and only those types which perform with the greatest efficiency are suggested for installation.

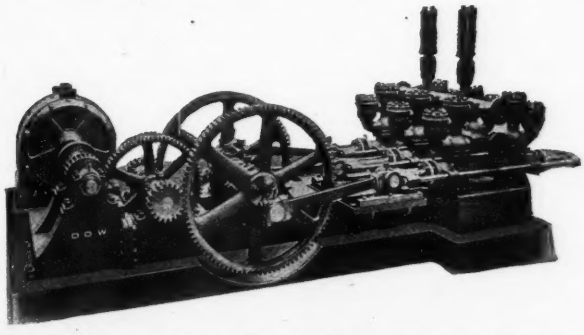


FIG. 5.—DOW TRIPLE AND DOUBLE PLUNGER PUMP, DRIVEN BY INDUCTION MOTOR.

The accompanying illustrations show some of the apparatus which the Westinghouse company has now on the market, which is especially adapted for use in mining installations. Fig. 1 shows a twenty-horse-power Westinghouse type C induction motor, Fig. 2 showing the rotating part or secondary. This motor has neither commutator nor brushes nor any other moving contacts. The winding consists simply of copper bars bolted at their ends to brass rings.

The stationary part of this machine is permanently connected to the main circuits, and the rotating part has no electrical connection with any external circuit, or, in fact, any contact or adjustments except the friction of the shaft in the bearings. The standard motors for 200 horse-power and smaller sizes are provided with a hollow cylindrical frame of cast iron, in which the primary is mounted. This frame forms a base for the machine, and also supports the two end brackets carrying the self-oiling bearings. The housing entirely encloses the primary and secondary elements, and protects them from any external damage.

The primary element consists of a hollow cylinder built up of laminated rings of sheet steel, slotted on the inside to receive the conductors. The rings are rigidly supported by the cast-iron housing that encloses the primary and forms the frame of the motor. The conductors are usually machine-wound coils of wire that are thoroughly insulated before being placed in the slots of the primary iron core. Instead of wire, in some of the larger motors a copper strap, bent to the proper form, is used for the coils.

The secondary, which is shown in Fig. 2, is built up of laminated discs made of a high grade of steel, mounted upon a spider, and carries the rectangular copper bars of the winding in partially closed slots around its periphery. This construction is practically indestructible by heating, and obviates any possible displacement of conductors or any accidental short-circuit.

Fig. 3 shows the Westinghouse direct-current series-wound mining motor, with a single reduction gear and gear case. These motors are most suitable for hoisting work, and the series motor has great practical value where a very high starting torque is desirable, but where close speed regulation is not required. Where there is any possibility that the motor might race, the compound-wound motor is used. The compound-wound motor has the high starting torque of the series motor, and, like the shunt motor, will not exceed a certain speed when the load is thrown off. Suitable controllers are supplied with these machines, consisting of an iron box containing resistance, a commutator composed of a number of contact blocks, each of which is connected to the resistance at suitable points, and a set of brushes mounted on a rocker-arm. The direction of rotation of the motor depends upon the direction in which the controller handle is moved from the neutral point. A typical controller is shown in Fig. 4. Fig. 5 shows a Dow triple and double plunger pump, four inches by six inches, driven by an induction motor.

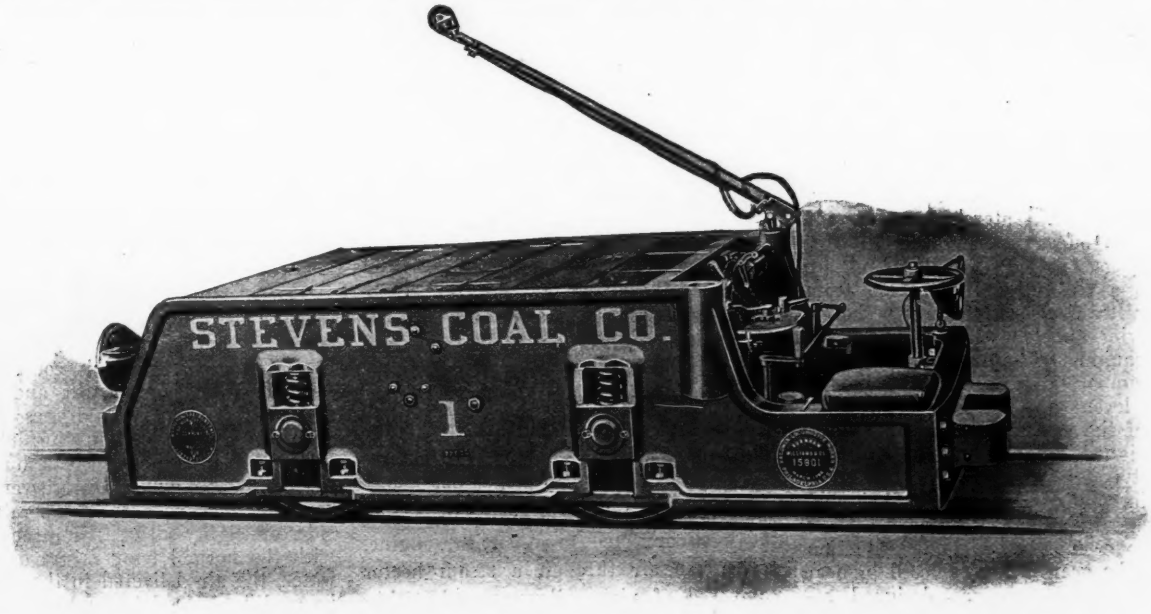


FIG. 6.—BALDWIN-WESTINGHOUSE MINING LOCOMOTIVE.

Fig. 6 shows the Baldwin-Westinghouse electric mining locomotive. Elec-

tric locomotives for mining service are divided into two classes—locomotives for surface haulage and for underground mine haulage. The use of these locomotives for mining purposes has passed the experimental period, and some of the largest mines in the country have been equipped with them. The amount of saving effected by the use of the electric locomotive for mine haulage in place of mules or other means of haulage will, of course, vary with the conditions that exist in each particular case. The cost of attendance is the chief item in which economy is found over the other methods of haulage, the cost of fuel, etc., being fairly comparable to that of feed, and a similar relation holding in depreciation charges. The saving in the item of attendance, however, has been found to be so great as to amount to a thirty per cent dividend upon the cost of electric installation.

The compactness of the electric locomotive makes it adaptable to low and narrow entries. There are no moving parts exposed to external injuries, the mechanism is of the simplest character, the running parts are readily accessible, and the cost of maintenance is brought to a minimum.

A valuable feature of the electric locomotive for mine service is that, while there is a variety of power service demanded in the mine, the power for operating the electric locomotive may conviently be furnished from the same electric generating plant that supplies current for lighting the mine, and the same is true equally of the pumping, ventilating, hosting, drilling and other work. At the same time, the electric system affords a simpler method of power distribution.

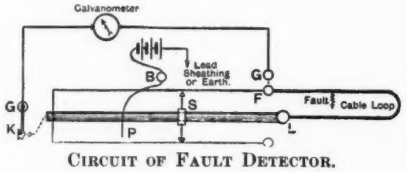
The standard type of locomotive frame consists of heavy cast-iron side and end-pieces, securely bolted together, and kept square by machine joints and shoulders, accurately fitted. Interchangeability of all parts is effected. The pedestal caps are forgings made to templet, and are fitted so as to relieve the frame from breaking strains in case of severe shocks. The driving-wheels and axles, bearings, brake equipment, operating platform, spring supports and accessories, in the way of levers and mechanical fittings, are all of the most substantial character, and designed to correspond with the highest type of locomotive building.

The locomotive is driven by two motors, separately spring-supported, one geared to each axle by single reduction gearing, the gears being enclosed in neat casings. The motors are designed especially for mine service, and are of the four-pole steel-clad enclosed railway type. The armature is of the ironclad type, the coils being held in slots below the surface, and secured from displacement as in the most improved railway service.

The current controller or starting device is of the latest type, with magnetic blow-out to prevent arcing at the contacts. It is provided with various speed changes, and is operated by handles for starting and reversing.

Fault Detector.

A simple portable instrument for the localization of faults on electric light and power mains is based on Mr. F. C. Raphael's principle, and gives a direct reading of the distance of the fault from the station by a simple balancing test. The test is independent of the resistance of the cables and by its means a fault of high resistance may be localized, as well as a dead earth or short-circuit. The connections for this instrument are shown in the diagram. The faulty cable is connected to terminal F, and a sound one, used to complete the loop, is connected to the terminal L. A sliding key S is set to indicate the length of the cable loop. Then the portable key P is shifted until a point is obtained where by pressing the galvanometer key K no deflection is obtained. The reading of the key P indicates the distance of the fault from the terminal F. If the cables are not the same cross-sectional area, or if they can not be connected to the instrument, suitable allowances must be made for the equivalent



CIRCUIT OF FAULT DETECTOR.

lengths of the cables. This instrument is being manufactured by Messrs. Nalder Brothers & Company, of Queen Anne's Gate, S. W., London.

Heating and Ventilating Telephone Exchanges.

The New England Telephone and Telegraph Company, of Boston, Mass., has given a great deal of attention to the heating and ventilating of its exchange. The ventilation is especially important, and arrangements are provided by which it can be maintained constant in volume independently of the amount of heat required or the state of the weather.

In the present plant, the fan, which is direct-connected to a vertical engine, forces the air through a steam heater composed of pipe coils, enclosed within a steel-plate housing. The heater, however, is by-passed, so that a greater or less proportion of the air may be forced into the distributing pipes without passing through it, and this by-pass is fitted with a special hot and cold damper arrangement which is automatically controlled by Johnson thermostats located in the several rooms of the building. The B. F. Sturtevant Company, Boston, Mass., by whom the fan and heater were installed, also supplied the galvanized iron piping elbows, fittings, registers and screens, together with the direct steam-heating work, automatic control and the boiler and boiler setting. The steam is delivered to the engine at twenty-five pounds pressure, and the exhaust passes into the heater.

A somewhat similar equipment was furnished by the above company to the Twin City Telephone Company, of St. Paul, Minn., some time ago. In this case special precaution was taken to purify the air supply. It has been stated that about ninety per cent of the trouble caused by imperfect contact in the switchboard connections can be prevented by thoroughly cleansing the air as it enters the building. Many experiments have been tried in the way of dry-cleaning by filtering through screens of wire and cheese-cloth or cotton-batting.

The action of the air-purifying and cooling apparatus adopted by the Twin City Telephone Company consists in thoroughly saturating the air with water by passing it through a fine spray and afterward precipitating the moisture with the collected impurities and discharging it into the sewer. The water which is taken up at high velocity and held in mechanical suspension is extracted by centrifugal force by passing it through a series of tubes in which spirals are so placed as to give the air a whirling motion, causing the suspended particles, which are heavier than the air, to be thrown outward and brought in contact with the tubes, from which they flow through perforations to a drip-pan below.

The washing process imparts about seventy per cent humidity at a temperature of seventy degrees Fahrenheit in the operating room. This is considered the most desirable for health and comfort and avoids the excessive dryness resulting with other systems of heating and ventilating which often require a humidostat to correct the defect. Moreover, in the summer time, with the temperature outside of eighty degrees Fahrenheit and with the normal temperature of the city water, the air delivered to the rooms can be readily reduced to seventy degrees.

The air after being tempered, washed and dried is blown by the fan through the reheating coils into the tempered air-chamber. A mixing damper is placed with connections to both, so arranged that the hot or tempered air, under the control of the Power's thermostat in the operating room, is mixed automatically to the proper degree, maintaining throughout the year a constant temperature in the room with uniform air delivery and humidity.

Some New Telephone Specialties.

The accompanying illustrations show a number of telephone specialties which have been developed by the De Veau Telephone Manufacturing Company, of 27 Rose street, New York city. Figs. 1 and 2 show the De Veau push-button telephone. This resembles the ordinary push-button, and can be used as such, but is still a complete telephone instrument, and may be used for intercommunicating,

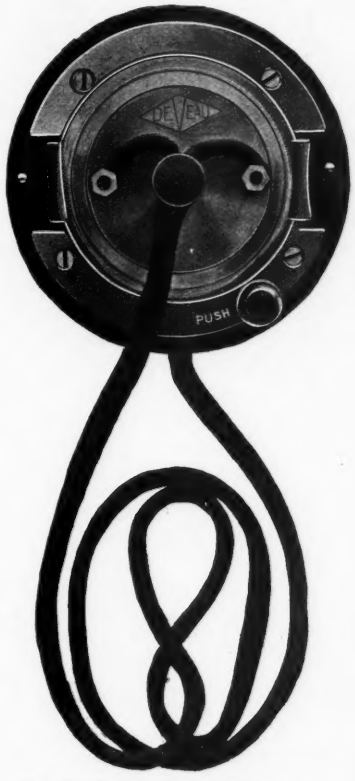


FIG. 1.—PUSH-BUTTON TELEPHONE.

FIG. 3.—SIDE VIEW.

switchboard or straight line work. The instruments are equipped with double-pole receiver and long-distance transmitter. All springs are of phosphor-bronze, have a long leverage, and are not turned at short angles. The base of the instrument is of composition, and the metal parts can be finished to match the hardware. The instrument is simple, compact and reliable.

These push-button telephones are so constructed that they can be used in intercommunicating, switchboard or straight line work, without making any changes in the connections. Complete wiring diagrams, showing connections for all the systems, are furnished with each instrument.

Fig. 2 shows the same type of telephone as Fig. 1, with the addition of an intercommunicating plug block. This arrangement has many advantageous features. The plug sets into a metal head, ensuring a perfect contact at all times. It is held by a chain, which ensures the availability of a plug at all times. The plug may be left in any jack, and the station can be called. This makes the instrument automatic, as it is not necessary to return to the home station to receive a call. With this type of telephone,

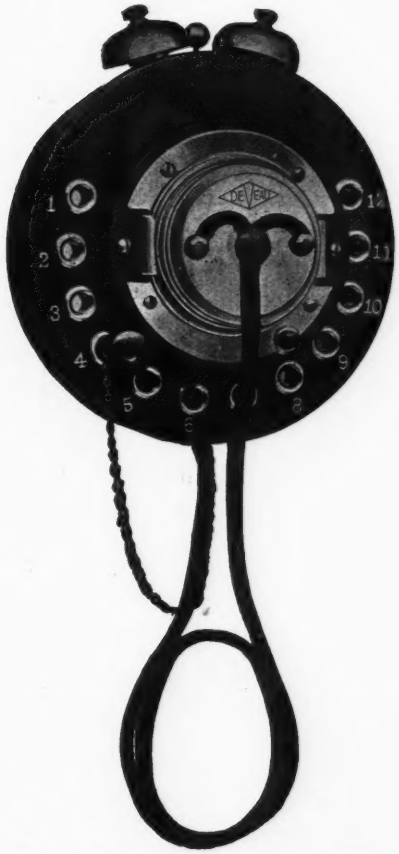


FIG. 2.—PUSH-BUTTON TELEPHONE, WITH PLUG CONTACTS.

together with a twelve-station outfit, six pairs can be talking at one time without interference.

Figs. 3 and 4 show the side view and

FIG. 4.—RECEIVER REMOVED.

the receiver removed, showing the transmitter. The watch-case receiver is of aluminum, and the push-button is of hard rubber. There has been a prejudice against the button in push-button telephones being placed in the centre of the receiver. This trouble has been obviated by placing the button in the transmitter frame-plate, it having no connection whatever with the transmitter or receiver.

Fig. 5 shows the De Veau patented automatic combination telephone and messenger call box. This is a telegraphic messenger system, only one battery being employed for any number of instruments and circuits. The line is normally open to battery, except when in actual use. The circuits are never open at any time, either

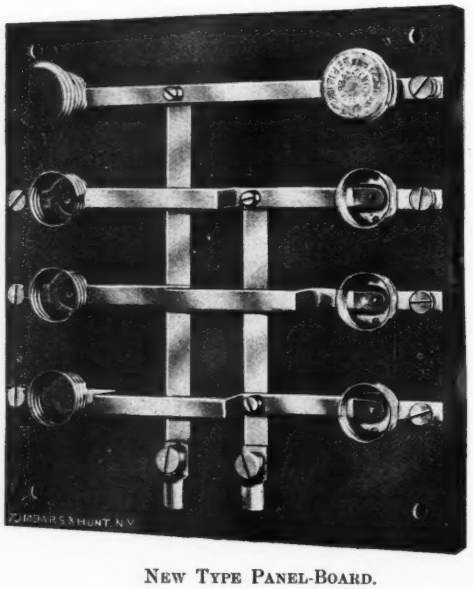
FIG. 5.—AUTOMATIC COMBINATION TELEPHONE AND MESSENGER CALL.

in conversation or in signaling. Signaling central office is accomplished by adding a ground. To make any desired call, by adjusting the teeth contacts, in and out of path movements of the inner arm contacts, designate any desired number that is necessary. The number of instruments on a line is not limited. When the instrument is hanging normal it is shunted out of circuit. It is noiseless, wheelless and springless. No contact springs or wheels are in the circuit. Subscribers can not converse with each other over this system, as no battery is on the circuit until "central" plugs in and gives it. An open wire does not affect the instrument in signaling over the line. If a "central" and a subscriber are talking, and a second subscriber comes in on the line, the signal is unheard by the first subscriber, but it is received by "central."

The valve in this instrument can be so adjusted that the call will be registered in the central office by the time the subscriber gets the telephone receiver to his ear.

A New Zimdars & Hunt Panel-Board.

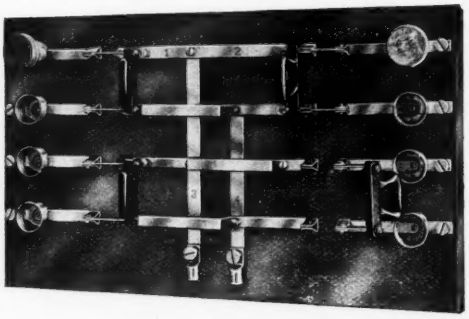
Zimdars & Hunt, of 127 Fifth avenue, New York, have just added to their line



NEW TYPE PANEL-BOARD.

a new type of panel-board which it is believed will meet with considerable favor. These panel-boards are made to take the common Edison plug, that old standby for protecting low-tension circuits carrying a few amperes. It seems eminently proper that a form of panel-board should be designed to make a more extended use of this device than that heretofore afforded by the common porcelain cutout block, for, of the many devices introduced in the earlier days of electric lighting, it is one of the very few that has not since been altered into unrecognizable form or discarded altogether.

The panel-boards now being introduced



NEW TYPE PANEL-BOARD.

by Zimdars & Hunt, two forms of which are shown in the illustrations, are made in all of the usual forms demanded in panel-boards generally, such as with and without branch or main switches, meter loops, fuse connections in mains, etc., and with two or three-wire mains. These panel-boards in other respects embody the well-known Zimdars & Hunt features to be found in all of this concern's panels.

A New Cable Bracket Frame.

Among the exhibits at the National Light Association convention, held in Chicago recently, was that of C. M. Gest, expert subway contractor of Cincinnati and New York.

Mr. Gest has invented and placed upon the market many valuable specialties for use in conduit construction, one of which,

NEW CABLE BRACKET FRAME.

"the Gest bracket frame," is illustrated herewith. The frame is made of angle iron heavily galvanized. As can be seen, the frame is supplied at top and bottom with anchors which, with the frame itself, are built in the wall, the face of frame being flush with the wall, thereby taking up no room in the manhole at all.

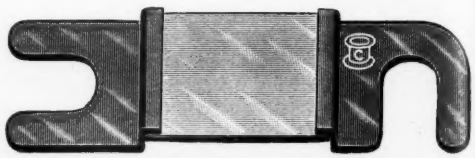
The cable bracket (galvanized cast iron) is secured to the frame by means of a galvanized T head-bolt with a special nut so designed that the bracket is removed by being lifted straight up. By means of the special nut the bracket can be adjusted to any angle, and as the slot in the frame is unobstructed from top to bottom the bracket can be adjusted to any height desired. The frames are made in the following lengths, twelve inches, twenty-four inches, thirty inches, thirty-six inches, forty-two inches, and the brackets are made in three sizes, single, double and triple. Longer frames than the above are made to special order.

The bracket bolts are removable at any time and very little time is required to change from a single bracket to a double or triple type.

All parts being heavily galvanized they will last as long as the conduit system itself.

Terminal for Copper-Tipped Fuse Links.

The Chicago Fuse Wire and Manufacturing Company, of Chicago, New York and Buffalo, has recently been granted a patent, No. 730,906, covering an improved terminal for copper-tipped fuse links. One form of this device is



TERMINAL FOR COPPER-TIPPED FUSE LINKS.

shown in the illustration herewith, this fuse being specially adapted for use in main cutouts and for dynamo fuses.

The manufacturer claims as special features a strong and reliable connection between the fuse and terminal, as the contact surface is very great. Another prominent point is the enhanced appearance of the completed fuse. It is also very compact.

The Chicago Fuse Wire and Manufacturing Company has been using this style of connection for some time, principally in connection with the larger sizes of fuses which are made from strip. The company will be glad to send its latest catalogue No. 14 upon request, showing a full line of its well-known fuse wire, strip, fuse links and telephone supplies.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

BOSTON-WORCESTER TROLLEYS—A new trolley line between Boston and Worcester, Mass., was scheduled for opening on July 1. The first car run over the new street railway was on the occasion of the official tour of inspection, and the railroad commissioners and officials of the road made the trip in a special car on Friday morning, June 26.

ST. LOUIS LIGHT CONSOLIDATION—The Union Electric Light and Power Company, of St. Louis, Mo., is to be a consolidation of the Imperial Electric Light, Heat and Power Company and the Citizens' Electric Lighting and Power Company with the Missouri Edison Electric Company. The company is capitalized at $10,000,000, and is at present erecting a large central power station at a cost of over $2,000,000, with a capacity of $50,000 horsepower. A ten-year contract has just been entered into with the St. Louis Transit Company, to supply the latter with a minimum of 12,000 horse-power.

MANILA ELECTRIC PROJECT—The Manila Electric Railroad and Lighting Corporation, of Hartford, Ct., with an authorized capitalization of $6,000,000, has filed a certificate of incorporation with the Secretary of State. The incorporators are Arthur L. Shipman, Charles W. Gross and Charles A. Goodwin. According to the terms of the charter the purpose of the company is to acquire, construct, equip, own, lease and operate in the city of Manila, Luzon, Philippine Islands, etc., street railroads, lighting, power and ice plants, ferryboats and vessels. The company is authorized to conduct its operations in any of the possessions of the United States, and to have its offices outside of the state of Connecticut.

JOHNSTOWN-CHAMBERSBURG TROLLEY—A movement is under way for the consolidation of all the electric railways and electric lighting plants between Cumberland, Md., and Johnstown, Pa., a distance of seventy-two miles. The entire mileage will be 150, and considerable new construction will have to be done in the way of connections. Among those announced as interested are Thomas T. Boswell, of Baltimore; S. J. Graham, of Cumberland; O. W. Kennedy, general manager of the H. C. Frick Coke Company; L. F. Rutn, Connellsville, Pa.; William Gibson, formerly general superintendent of the Baltimore & Ohio Railroad, and Charles Donnelly, president of the Pittsburg & Terminal Railway. To carry out this consolidation the Johnstown & Cumberland Electric Railway Company has been incorporated in New Jersey.

MEXICAN ELECTRICAL DEVELOPMENTS—American interests are to build another extensive power transmission system in Mexico. A new project is to furnish the cities of Chihuahua and Parral, and mines along the route, with energy for lighting, traction, manufacturing and general power purposes. The Conchos River Power Company will build the plant and operate the system. The power plant is to be located at La Joya, on the Conchos River. The initial equipment will be a 3,200-horse-power plant, although it is expected that 30,000 horse-power will be generated ultimately. Four units of 800 horse-power each will be employed in the present installation. The available head is 125 feet. Chihuahua is eighty miles distant from the power-house site, and Parral is eighty-six miles away. The transmission line will operate at 40,000 volts. The concession was originally granted by the Mexican authorities to R. M. Burke, formerly United States consul stationed in Chihuahua. Mr. Frank H. Wright is at the head of the installing company. Two other important power transmission lines are now under construction in Mexico. These are the Guanajuato Light and Power Company and the Mexico Light and Power Company, Limited. The Guanajuato company is building a large power-house on the Douro River, the power to be transmitted a distance of some 125 miles. The Mexico company will ultimately generate 80,000 horse-power, the power-house to be constructed near Huauchinango, the energy being transmitted to Mexico City, ninety miles distant.

GEORGIA LIGHTING INTERESTS MERGED—It is announced that the entire street and house lighting facilities of Atlanta, Ga., are now under the control of the H. M. Atkinson interests, a merger of the Georgia Railway and Electric Company and the Atlanta Gas Light Company having been effected. The following statement has been issued from the office of Preston S. Arkwright, president of the Georgia Railway and Electric Company: "The parties interested in the Georgia Railway and Electric Company and the Atlanta Gas Light Company have arranged for an exchange of the stock of the companies. By the terms of the exchange the present stockholders of the Atlanta Gas Light Company will become largely interested in the Georgia Railway and Electric Company. They hold at present $600,000 par value preferred stock, and $1,014,625 par value of the common stock of the Atlanta Gas Light Company. They receive in exchange for this a like amount, par value, of the common and preferred stock of the Georgia Railway and Electric Company. There will be no consolidation of the two companies, but they will continue to be operated as separate and independent organizations. By the exchange, however, the ownership of the two companies is common, and they will be brought in closer touch with each other, will be able to purchase their supplies jointly, and by this means it is believed that economies in the operation of each can be effected and higher efficiency and better service accomplished in all departments of both companies. The management of each company will remain the same as it is now."

ELECTRIC LIGHTING.

WINONA, MINN.—An electric light plant will be installed at Spring Grove.

HACKENSACK, N. J.—It is stated that Park Ridge is to have a municipal electric lighting plant, to cost $15,000.

MILWAUKEE, WIS.—The Milwaukee Electric Railway and Light Company has begun active operations on its plant at West Allis.

GRANDVIEW, TEX.—A franchise has been granted to W. B. Head for an electric light plant, which will be put in as soon as possible.

ROCKVILLE, MD.—The town of Rockville has entered into an agreement with Joseph Schreiber, of Baltimore, to light the town with electricity.

WASP, IOWA—At a special election it was decided to install an electric light plant, to be in operation within ninety days. The contract was awarded to J. K. Alline, of Fort Dodge.

MARION, IND.—A company with a capital of $25,000 has been orgainzed at Converse for the purpose of taking over the public utilities of the town, including the electric light and telephone plant.

MACON, GA.—Work is progressing on the dam which is being built on the Oconee, near Milledgeville. The object of this work is to secure power for generating electricity for Macon and other cities and towns in this section. It is expected that 25,000 horsepower will be developed.

OCEAN SPRINGS, LA.—A contract has been entered into with the Biloxi Electric Light and Street Railway Company to light the streets of the town for a period of ten years. The company was granted a twenty-five-year franchise to erect and maintain an electric light system in this city. The system will be in operation in about six months.

TROY, N. Y.—The Edison Electric Light and Power Company, of Amsterdam, has been incorporated with the Secretary of State, the company being the outcome of the merger of the Edison Electric Light and Power Company and the Amsterdam Arc Light Company. The new company proposes to operate in the counties of Montgomery, Fulton, Schenectady, Herkimer, Schoharie and Saratoga. Its principal place of business is to be in Gloversville. The capital stock is $23,000.

ELECTRIC RAILWAYS.

CINCINNATI, OHIO—The Cincinnati, Milford & Loveland Traction Company has closed a deal whereby it acquires the right of way, privileges and interests of the Cincinati, Milford & Eastern Traction Company.

PHILADELPHIA, PA.—The Bustleton & Byberry Rapid Transit Street Railway Company has been chartered with a capital of $120,000, to build a road twenty miles long between Frankford and Byberry. Building will begin shortly.

LANSING, MICH.—Articles of incorporation of the Jackson, Ann Arbor & Detroit Traction Company, capitalized at $2,500,000, have been filed with the Secretary of State. The company will extend the Boland electric line and operate it.

JANESVILLE, WIS.—The council has granted a franchise to the Janesville Traction Company, which proposes to construct a line from Janesville to Madison, by way of Stoughton and Edgerton. The line is to be completed in three years.

NASHVILLE, TENN.—All the property of the Nashville Railway was sold recently by a special master of the United States Circuit Court. The purchaser was Colonel A. M. Shook, representing the former stockholders, and the price paid was $500,000.

OMAHA, NEB.—Callahan Brothers & Katz have been awarded the contract for building thirty-five miles of electric road from Indianapolis to Rushville, Ind. The road will be double-tracked all the way, and will cost in the neighborhood of $1,000,000. Work will begin at once.

LANSING, MICH.—The Grand Rapids & Southern Traction Company, organized with $1,300,000 capital to build an electric road from Battle Creek to Gull Lake, Prairieville, Gun Lake and other places to Grand Rapids, has filed articles of incorporation with the Secretary of State.

ALBANY, N. Y.—The Court of Appeals has sustained the permission granted by the State Railroad Commissioners for a third-rail electric railroad by the Portchester Electric Railroad, from the Harlem River, through Westchester County to Porchester. The road is to connect with the New York subway.

CINCINNATI, OHIO—The Cincinnati, Lawrenceburg & Aurora Electric Street Railway Company will shortly begin extending its line from Aurora to Rising Sun, Ind., nine and one-half miles. The surveying of the right of way has been finished. The company expects to have cars running by the last of the year.

DES MOINES, IOWA—Articles of incorporation for the Western Iowa Interurban Railway Company, which is to have its principal place of business in Des Moines, were filed recently with the county recorder. The capital stock is placed at $100,000. The company will build a line from Des Moines to Council Bluffs.

TOLEDO, OHIO—The Louisville & New Albany Traction Company has been incorporated with a capital stock of $3,000,000. James W. Dunbar, of New Albany; J. F. Stratton, of Jeffersonville; Samuel Insull, representing R. W. White and other Chicago interests, and J. O. English are directors. The length of the lines will be nearly 200 miles.

AUGUSTA, GA.—Messrs. George E. Coughlin and Frank Wilson are at the head of an enterprise to build an electric line from Anderson to Greenville, a distance of thirty-six miles. It will pass through the towns of Piedmont, Belton, Williamston and Pelzer. Power will be generated from the water power of the Savannah, Tugalo and Saluda rivers. About $1,000,000 will be invested.

KINGSTON, N. Y.—The property and franchises of the New Paltz & Poughkeepsie Traction Company, which operates over the Poughkeepsie Bridge, have been sold at auction under foreclosure of a mortgage by the Franklin Trust Company, of New York, to Charles J. Rowe, a New Jersey lawyer, for $20,000. The mortgage was for $1,000,000. Mr. Rowe is believed to represent the trust company.

ALBANY, N. Y.—The Ithaca-Cortland Traction Company has been incorporated with a capital of $200,000, to operate from Cortland to Ithaca a street surface railroad. The directors are Howard L. Chandler, Ogden Armstrong, F. C. Howell, J. B. Staley and C. T. Leland, of Philadelphia; C. J. Harrington and J. W. Laughran, of New York city; J. P. Archer, of Camden, N. J., and E. H. Chandler, of Atlantic City.

TELEPHONE AND TELEGRAPH.

RICHMOND, VA.—The Salisbury Telephone Company is building a system in Spencer.

OAKLAND, CAL.—It is said that Colton is soon to have a telephone system under city ownership.

CHICAGO, ILL.—The Chicago Telephone Company will build a $25,000 exchange building in Austin.

GREENVILLE, TENN.—A new telephone line will soon be built from Sacteels Mill into Greenville.

INDIANAPOLIS, IND.—The Lynn Local Telephone Company has filed a notice of an increase in capital stock from $8,000 to $15,000.

LEAVENWORTH, KAN.—The Missouri & Kansas City Telephone Company will build a new telephone exchange building in this city.

LITTLE FALLS, N. Y.—A telephone line is to be established from Grant to Gray and thence to Cold Brook, a distance of about fourteen miles.

MUSCATINE, IOWA.—The Madura Telephone Company has filed articles of incorporation. The company will operate in Muscatine and Louisa counties.

MEMPHIS, TENN.—The city council has granted the Cumberland Telephone and Telegraph Company a thirty-year franchise over and under the streets of the city.

HARTFORD, CT.—The Gagnon Selective Telephone Company has been incorporated with a capital of $10,000. Amos Gagnon, Michael F. Brown and Michael Gillicuddy, of Stafford Springs, are the incorporators.

NEW INCORPORATIONS.

PENN YAN, N. Y.—Friend Telephone Company. $5,000.

FITCHVILLE, OHIO—The Clinton Air Telephone Company. $1,000.

SUMPTER, ORE.—Sumpter Light and Water Company. $150,000.

HARRISBURG, PA.—The Pottsgrove Traction Company. $130,000.

TAZEWELL, VA.—Clear Fork Telephone Company. Increased to $4,000.

CANANDAIGUA, N. Y.—People's Telephone Company. Increased to $25,000.

BAY CITY, TEX.—The Bay City Ice, Light and Power Company. $50,000.

DOYLESTOWN, PA.—The Hatboro & Hartsville Street Railway Company. $36,000.

BURLINGTON, IOWA—The Modern Telephone Company. $300.000. Incorporators: W. W. Copeland, H. A. Brown, J. H. Pettibone.

BOZEMAN, MONT.—The People's Electric Light and Power Company. $50,000. Directors: F. L. Benepe, George Flanders and G. L. Hogan.

JEFFERSON CITY, MO.—Cape Girardeau Bell Telephone Company. $20,000. Incorporators: John F. La Peck, Henry L. Rozier and Edgar J. Rozier.

PARKERSBURG, W. VA.—The Southern States Telegraph and Telephone Company. $25,000. Incorporators: H. Tisdale, John Stander, Samuel Trissler and Harry Budd.

RICHMOND, VA.—The Carolina & Henrietta Telephone Company. $10,000. Incorporators: Edward Thompson, R. P. Scruggs, Jr., Thomas P. Rennolis, J. M. Turnley, B. B. Doggett and others.

FRANKLIN, MINN.—Franklin Local and Rural Telephone Company. $3,000. Incorporators: C. W. Parsons, Henry Dittes, A. J. Olin, Daniel Whetstone, R. E. O'Keefe, H. B. Cole, L. H. Kirwin, and others.

CHARLESTON, W. VA.—Salem Terminal Traction Company. $260,000. Incorporators: C. E. Barnes, Pittsburg, Pa.; J. T. McGraw, Grafton; H. B. McKinley, Salem, W. Va.; J. E. Law, Clarksburg; W. T. Henis, of Uniontown, Pa., and others.

ELECTRICAL SECURITIES.

The hopes that the past week would see a decided rally in market prices were evidently discounted by reason of the holiday spirit which pervaded the exchanges in general. Outside of the apathy which has prevailed for some months, the methods of several large and influential speculative interests have caused a tendency toward conservatism and a leaning to bear operations. The present outlook is more or less clouded, due to the conflicting reports from industrial and agricultural centres. The July crop report will do much to shape and influence buying for the balance of the year. Half-yearly statements from centres of industry will also give a better view of these conditions, and there is every possibility that with the recurrence of high-class statistics the market will continue firm, even if prices are not advanced for some time.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JULY 4.

New York:	*Closing.*
Brooklyn Rapid Transit	58⅜
Consolidated Gas	192½
General Electric	177
Kings County Electric	200
Manhattan Elevated	137
Metropolitan Street Railway	123
New York & New Jersey Telephone	155
Westinghouse Manufacturing Company	190

Philadelphia:	*Closing.*
Electric Company of America	8⅝
Electric Storage Battery common	62
Electric Storage Battery preferred	62
Philadelphia Electric	6
Union Traction	45
United Gas Improvement	88½

Electric Company of America directors have declared the regular semi-annual dividend of thirty cents per share out of the earnings for the six months ending June 30 last. The dividend, which is at the rate of six per cent per annum, is payable July 31 to stockholders of record July 20. Books close July 20 and reopen August 1.

Boston:	*Closing.*
American Telephone and Telegraph	132¾
Edison Electric Illuminating	245
Massachusetts Electric	83¼
New England Telephone	130
Western Telephone & Telegraph preferred	89

Chicago:	*Closing.*
Chicago Telephone	124
Chicago Edison Light	150
Metropolitan Elevated preferred	66
National Carbon common	23
National Carbon preferred	93
Union Traction common	3½
Union Traction preferred	32

Metropolitan Elevated, for the half year ended June 30, has maintained an average gain of ten per cent over the corresponding period of 1902. The daily average for the half year is $114,000, against $103,500 for similar period last year.

PERSONAL MENTION.

PROFESSOR R. B. OWENS has received the degree of Doctor of Science from McGill University, Montreal, Canada.

MR. O. F. CONKLIN, head of the electrical department of the Robbins & Myers Company, of Springfield, Ohio, was a New York visitor last week.

MR. THOMAS M. GOGIN, treasurer and manager of the American Thermo-Call Company, of Boston, Mass., was a visitor to New York city last week.

MR. HENRY W. BROOKS, JR., has resigned as director and treasurer of the McCreary Electric Company, and will hereafter devote his attention to his construction interests.

MR. WILLIAM CURRIE, of the Stanley Electric Manufacturing Company, who for some time has been at the Pittsfield works as Mr. C. C. Chesney's assistant, has been appointed sales engineer of the Chicago office of the company.

MR. TITUS ULKE has recently been transferred from the position of assistant inspector to that of mechanical draftsman of the ordinance department of the Watervliet Arsenal, near Troy, N. Y.

MR. WILLIAM W. DEAN, for many years an engineer with the Kellogg Switchboard and Supply Company, has resigned to accept an appointment as consulting engineer for the Consolidated Fire-Alarm Company, of New York city.

MR. G. A. BOWERS, who recently resigned as master mechanic of the Southern Railway, at Alexandria, Va., has been appointed master mechanic of the Baltimore & Annapolis Short Line and the Washington, Baltimore & Annapolis, at Annapolis, Md.

MR. B. H. SCRANTON, president and general manager of the American Electrical Heater Company, of Detroit, Mich., has been at the Park Avenue Hotel, New York, for ten days, and during his return trip spent a few days at Madison, Ct., his birthplace.

PROFESSOR WILLIAM ESTY has been placed at the head of the electrical engineering department of Lehigh University, Bethlehem, Pa. The department of engineering is now a separate function from that of the department of physics at the university.

MR. J. A. HOLMES, chief of the department of mining and metallurgy of the Louisiana Purchase Exposition, has returned to St. Louis after a prolonged eastern trip, where arrangements have been made by him for a very complete exhibition of iron and steel processes and products.

M. HENRI POINCARE has received the honorary degree of Doctor of Science from the University of Oxford; the honorary degree of Doctor of Laws of the University has been conferred upon His Royal Highness Prince of Wales, Lord Kelvin and Lord Lister, and the honorary degree of D. C. L. of Durham University has been conferred upon Dr. Joseph Larmor.

MR. ALFRED H. SMITH has been appointed general manager of the New York Central & Hudson River Railroad, assuming the new position on July 1. Mr. Smith began his railroad career twenty-five years ago, in the office of the Lake Shore Railroad, in Cleveland, and for two years carried messages for the officers of that company. His rise has been gradual, though steady, and he has been, in turn, brakeman, conductor, telegraph operator, train despatcher, division superintendent and general superintendent. Mr. Smith has for a year and a half been general superintendent under William C. Brown, third vice-president and general manager. Mr. Smith will relieve his chief, Mr. Brown, of a part of his work, which, as a result of combining the four operating departments, has grown considerably since Mr. Brown came from Cleveland in February, 1902.

OBITUARY NOTICES.

MR. J. A. HESSE, of Atlanta, Ga., died suddenly in Boston, Mass., on June 29, while on a business trip to that city. Mr. Hesse has been identified with the commercial side of the electrical industries for many years, and for the past four years has represented the Fort Wayne Electric Works in the South. Mr. Hesse was well known to many of the pioneers in the trade. Announcement of his death will be read with great sorrow by a large acquaintanceship in the field. The funeral was held at Lima, Ohio, Thursday, July 2.

MR. CHARLES C. BARTON died on June 28 at his home, 29 West Twenty-sixth street, New York city. Mr. Barton was born in Rochester in 1840, and was the son of the president of the Barton Tool Company. He was graduated from Rochester University, and at the breaking out of the Civil War joined the Ninety-eighth New York Volunteer Regiment. He won promotion during the war, and served on the staff of General Halleck and General Grant at Vicksburg. Since the war ne had devoted himself to invention, chiefly along electrical lines, and had invented several appliances now in general use.

INDUSTRIAL ITEMS.

THE HART MANUFACTURING COMPANY, Hartford, Ct., has moved into a large new building well equipped for manufacturing purposes. This company makes the celebrated "Diamond H" switches.

THE NATIONAL TELEPHONE SUPPLY COMPANY, Cleveland, Ohio, is manufacturing a new form of cable hanger, which is claimed to be especially adapted for telephone and electric light line service and to be extremely simple and permanent.

THE GLACIER METAL COMPANY, of New York and London, has recently opened an office at Richmond, Va., to facilitate the handling of its increased trade in that locality. "Glacier" metal is a high-grade Babbitt used for high-speed and heavy running machines.

THE NATIONAL WIRE CORPORATION, New Haven, Ct., manufacturer of wire, rods and wire nails, has issued a new bulletin giving special prices on galvanized telegraph and telephone wire and wire strand. This bulletin may be had on request to the company.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., and Rochester, N. Y., has recently sold a magneto switchboard to the Deerfield Telephone Company, North Benton, Ohio, and a large number of bridging telephones to the Clinton Telephone Company, Wilmington, Ohio.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is sending out an illustrated circular descriptive of the new cartridge fuse designated as the McBride "Arkless," for which this company is the selling agent. The fuse is adapted for all classes of work, and is made for 125 and 250 volts, and in capacities from three to thirty amperes.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, celebrated its eighteenth annual outing on Saturday, June 27, at Olentangy Park, Columbus, Ohio. A number of athletic events were held, valuable prizes being awarded to the winners. After the athletic events, a four-act play was given, which was followed by dancing.

THE C. W. HUNT COMPANY, West New Brighton, Staten Island, N. Y., will be pleased to send its latest catalogue, entitled "Coal-Handling Machinery," to any one interested, upon request. This describes and illustrates coal-handling machinery for power stations, boiler rooms, coaling stations, gas companies, coal yards, shipping docks, manufactories, etc.

THE REYNOLDS ELECTRIC FLASHER MANUFACTURING COMPANY, 225 Fifth avenue, Chicago, Ill., manufacturer of the improved Reynolds electric sign flashers, will be pleased to send on request its pamphlet, "What's a Flasher," which describes in a short, terse manner what these flashers may be used for, and of their business bringing and money saving possibilities.

THE CANADIAN GENERAL ELECTRIC COMPANY, Limited, Toronto, Province of Ontario, Canada, is now representing the Electric Storage Battery Company in the sale of the chloride accumulator and the exide accumulator throughout Canada. All enquiries from Canada, in regard to storage batteries, should be addressed to the Canadian General Electric Company, Limited.

MR. H. T. HOCHHAUSEN has sold his business to the Metropolitan Engineering Company, of which firm he will assume the entire management. The company will be located at 27 Sixth avenue, Brooklyn, N. Y. It will have a splendidly equipped factory for the manufacture of signs of every description. The specialty will be electrical signs and effects. This company will be pleased to correspond with electric light men regarding signs and fixtures.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, is about ready to occupy its large, new factory, for the manufacture of power motors and transformers, the motors being a new line with this concern. Mr. H. E. Temple, for the past seven years with the Bullock Electric Manufacturing Company, of Cincinnati, Ohio, becomes general superintendent of the Peerless company's plant.

THE AMERICAN STEEL AND WIRE COMPANY, Chicago, Ill., has recently published a number of interesting bulletins descriptive of its products. These include wire of every description, wire hoops, electrical wires and cables, telegraph and telephone wire, rail bonds, wire rope, nails, staples, spikes and tacks, barbed wire and woven wire fencing, springs, Venetian red and oxides of iron, poultry netting, wire rods, horseshoes, shafting, cold-drawn steel, and plates and sheets.

THE INTERNATIONAL POWER COMPANY, 253 Broadway, New York, operating the George H. Corliss Engine Works, at Providence, R. I., and builders of the Diesel engine, has recently conducted a series of tests on an American engine eleven and one-quarter inches by twenty inches, built in America, and a German engine ten and fifteen-sixteenths inches by sixteen and one-sixteenth inches, built in Germany. These tests showed a large advantage in favor of the American-built engine. The International Power Company will be pleased to answer any correspondence regarding statistics concerning the Diesel engine.

THE ADVANCE THRESHING MACHINE COMPANY, the J. I. Case Threshing Machine Company, the J. I. Case Implement Company, the Bement-Darling Company and the Adland Transfer and Storage Company, five of the prominent implement and machine jobbers of Minneapolis, Minn., whose buildings are located in close proximity, are figuring on the advisability of putting in a joint plant for the purpose of heating, lighting and furnishing power for their buildings. Four of these buildings are each seven stories high and the fifth is five stories high. The J. I. Case Implement Company, 622 and 628 South Third street, Minneapolis, Minn., will have charge of the installation.

THE MICHIGAN CENTRAL (the Niagara Falls Route) has published a handsome booklet descriptive of summer tours to the Thousand Islands, the White Mountains, the Adirondacks, Saratoga, the Berkshires, Poland Springs, the New England coast, New York and the seashore. The reading matter is supplemented by numerous half-tone engravings, depicting typical scenes in different parts of the country traversed by this system. A number of routes and rates are added, the classifications making a quick survey possible. A large map in colors helps the reader to a ready understanding of the topography of the country. Mr. R. H. L'Hommedieu is the general superintendent, at Detroit, and Mr. O. W. Ruggles is the general passenger and ticket agent, at Chicago.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has issued an attractive circular describing its graphite pipe-joint compound. This graphite pipe-joint compound has been on the market now for more than twenty years, and its chief feature lies in the fact that graphite is a lubricant, and does not form with the oil a hard, brittle compound which would bind the joint against any future release. This compound rubbed on the surface of gaskets enables them to be removed easily, so that they can be used again. It also has a useful application in slushing bolts for insertion into green woodwork, preventing entirely any rusting of the bolt. The applications are, in fact, very numerous, and the length of time this material has been on the market, during which time it has won commendation from all classes of users, is a guarantee of its merit.

THE OTIS ELEVATOR COMPANY, 71 Broadway, New York city, is distributing a handsome booklet descriptive of its electric elevators. This company has in actual operation more than 6,000 electric machines in the United States and foreign countries. The electric elevators are particularly well adapted for private residence service, as with the improved push-button system of control a regular attendant is unnecessary. The machine can be operated both from the car and hallways. By pressing a button placed in a hallway, the car can be brought to that floor, stopping automatically when opposite the landing. Inside the car is placed a series of buttons, numbered to correspond with the various floors, and by pressing one of these the passenger can send the car to the desired landing, or, by pressing the safety button, can stop the car at any point in its travel. While the car is in motion the hall buttons are inoperative, giving the person in the car entire control of the elevator. The enclosure doors are provided with an automatic interlocking door fixture which prevents the opening of any door until the car is opposite it, and prevents the moving of the car until the door is securely closed.